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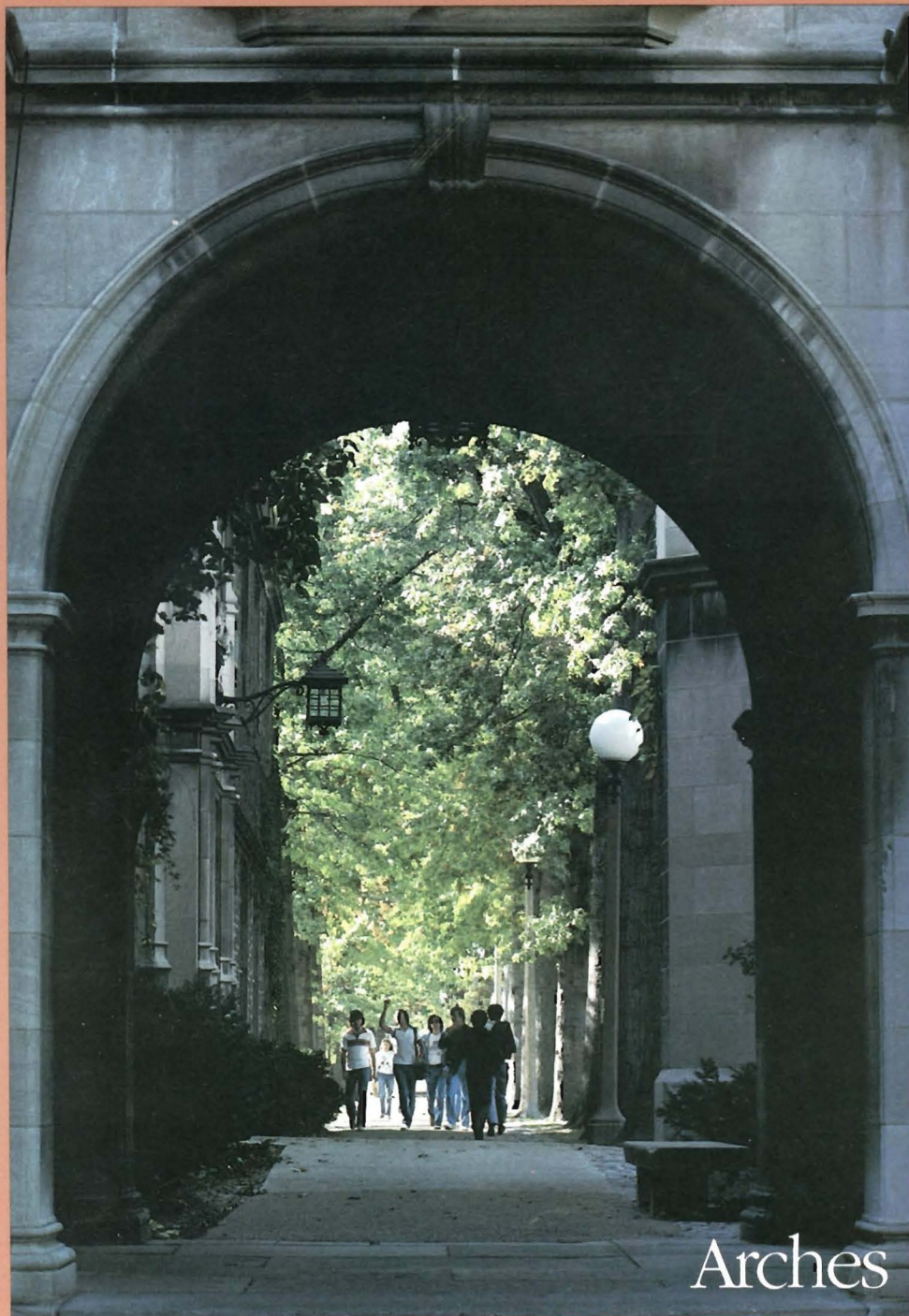


WASHINGTON
UNIVERSITY
IN ST. LOUIS

Washington University

Spring 1983

Magazine



Arches

Arts and Letters

Two faculty members of Washington University's Writers' Program, novelist and essayist William Gass and poet Mona Van Duyn, were elected this spring to the Institute of the American Academy and Institute of Arts and Letters. The selection brings to four the number of Washington University faculty writers who hold that membership: Gass, Van Duyn, novelist Stanley Elkin, and poet Howard Nemerov.

Of the election, John Morris, professor of English and director of the writers' program, commented, "Surely it is remarkable that at any one moment four teachers in any one writing program should be members of the Institute."

The American Academy and Institute is a 250-member group originally founded in 1898 and chartered by Congress in 1912 to honor Americans of notable achievement in art, music, and literature. Members are selected by their peers.

Gass and Van Duyn will be inducted with eleven other new members in May. Elkin was elected last spring. Nemerov, elected a number of years ago, is also a member of the elite fifty-member Academy.



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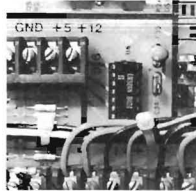
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On the cover: Looking west through the January-Ridgley arch. See Arches, page 16.



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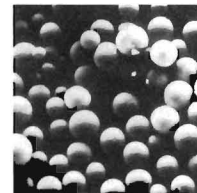
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Snug As A Bug

Imagine facing a \$1 million fuel and electric bill in 1975, seeing that double in four years and, in addition, facing the prospect that costs would continue to double about every four years hence. Imagine, then, yourself in Washington University's shoes. In 1979, enlisting the support of its building and grounds advisory committee, which includes many top engineers, the University began a massive energy conservation program. It had already done the obvious by putting timers on lights in the library stacks, on almost all window air conditioners, and on some other lights. Clearly, new systems were needed.

After studying needs and possible solutions, Washington University borrowed some \$4 million for a nearly \$4.75 million program (the remainder came as a grant from the Department of Energy) to embark on major cost-cutting systems. New insulated roofs and windows were put on most buildings;

electrical and heating systems were overhauled to use more coal and less natural gas; new chilled-water cooling units were introduced and, in some places, innovative electric management systems were installed to adjust heating and cooling to classroom building use.

"Our biggest savings to date has been in fuel costs," said Lawrence O'Neill, administrator of physical facilities. "And our better electrical controls and various innovative systems and procedures should enable us to offset future increases."

"The cost-avoidance savings in 1982 was \$827,843," said Joseph Evans, associate vice chancellor and coordinator of the program. "That already exceeds the interests charges on our loan by more than \$200,000. Based on results to date, the energy savings will pay back all interest and principal in ten years."

What he didn't say was that all of those drafty hallways, classrooms, and offices of yesteryear are no more. Even the 1904 World's Fair buildings are snug as a bug.

In this time of critical need for more student support, the full-time faculty of George Warren Brown School of Social Work has pooled its resources to establish a student fellowship. Faculty members have committed the support to a minimum of \$1,000 annually, beginning in the fall. "The faculty, aside from being one of the most scholarly in the country, is a group of caring teachers," said Dean Shanti Khinduka, commenting on the first such award at the University to be thus supported.

Designer Genes

A major new step to enhance cooperation between St. Louis industry and Washington University and to bring both into the forefront of biotechnology research was taken last fall as the University established a Center for Biotechnology. Its focus is threefold: to promote research in the field, to train researchers and practitioners, and to coordinate industrial collaboration.

Biotechnology uses biological routes to achieve chemical changes. Its earliest application, dating back to before 6000 B.C., was for fermentation. The Sumerians and Babylonians used yeast to make beer. Today, products as diverse as drugs, gasahol, pesticides, and feed supplements are made via biological routes involving microbes—such as yeast and bacteria—and plant and animal cells.

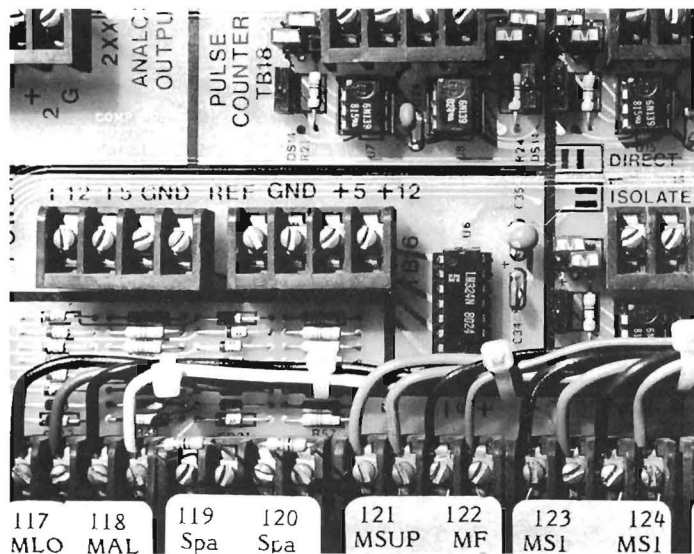
Recent developments in genetics have made possible entirely new applications. Genetically engineered bacteria now produce human insulin and interferon, and an oil-eating bacteria may clean up spills or extract new oil from worn-out wells.

"We plan a center in the true sense of the word," says William D. Phillips, the Charles Allen Thomas Professor of Chemistry and chairman of the chemistry

department, who is acting director. "We will bring together investigators and teachers from chemistry, biology, engineering, and the medical school and from many and varied industries. There is enormous interest here in biotechnology." Interest, encouragement, participation, and support have already come from Monsanto and Ralston Purina.

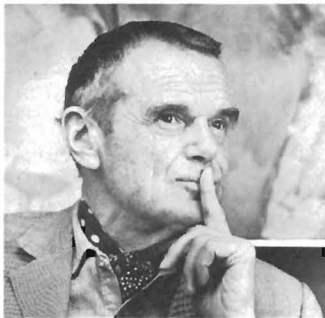
Eric H. Dunlop, professor of chemical engineering who recently joined the University from industrial work in Britain as a biotechnology specialist, last fall taught the center's first course. He will create courses in industrial biotechnology, bioreactor design, bioseparation or isolation of biological products and other topics. The coursework will lead first to a master's degree and eventually to a doctoral degree in biotechnology offered through traditional departments. Dunlop's introductory course not only attracted undergraduate and graduate students but faculty, administrators, and industrial personnel as well.

The center currently uses a laboratory in engineering's Urbauer Hall. A proposal for additional facilities in the department of biology is under consideration by the National Institutes of Health.



Eames Memorial

The Washington University School of Architecture is one of ten institutions selected by Herman Miller, Inc. of Michigan to share in a special program honoring the late Charles Eames. Eames, who studied architecture at Washington University in the 1920s, was once identified by *Fortune* magazine as "America's most celebrated designer."



The Miller awards, announced at Cranbrook Institute of Art in Bloomfield Hills, Michigan, will enable each school to host an Eames Memorial Lecture each year for three years and will give each institution fourteen of the films made by Charles Eames and his wife, Ray. The Eameses frequently collaborated on design of films, exhibitions, and furniture. Other recipients of the Miller awards are: the Art Institute of Chicago, Cooper Union, Cranbrook, Harvard University, National Building Museum, Rhode Island School of Design, University of California at Los Angeles, University of Cincinnati, and the University of Michigan.

Ralph Caplan, author of *The Design of Herman Miller: Connections*, a monograph on the work of Charles

and Ray Eames, delivered the inaugural Eames Memorial Lecture at Washington University in

February. Caplan is a New York City writer, communications design consultant, and educator.



Winners

A team of undergraduate business students from Washington University won first place in the University of Virginia's McIntire Commerce Invitational, a national business case competition. They bested teams from Michigan State and Pennsylvania State universities and the universities of Texas-Austin and Southern California. USC was last year's winner.

Team members—seniors Stephen Miller, Heene Lobell, Paul Luhmann, and Mark Ventling and alternate junior Steven Baker—analyzed an eighty-five page case statement on the Marriott Corporation and during the three-day contest presented written and oral reports recommending future business strategy. The contest, judged by industrial and academic business leaders, was initiated in 1980 by students from the McIntire School of Commerce, University of Virginia. Each year four new schools and the previous year's winner are invited to compete. The contest is solely for undergraduates.



Chewing Sticks

Memory Elvin-Lewis, professor of microbiology in biomedical sciences at Washington University School of Dental Medicine who says chew sticks are nature's toothbrushes, notes that for a quarter of the world's population these time-honored twigs may be an "advanced" technology—a disposable, biodegradable, combination toothbrush and toothpaste. The research that has carried her around the globe has identified 200 varieties of chewing sticks used in most of rural Africa, much of Asia, and some areas of the Americas, as well as in history. She and her husband, Washington University biology professor Walter H. Lewis, are trying to determine whether chewing sticks contain substances that prevent cavities and even gum disease, as well as promote good dental hygiene.

Most chewing stick users, she says, "break off a pencil-size twig from a bush or tree, peel back the bark and fray the end by gnawing or pounding before vigorously moving it up and down their teeth. They're often very, very fastidious about it and usually spend fifteen or twenty minutes at it. In an African village, if you get up at 5 or 6 a.m., you see everybody out with their chewing sticks." Through trial and error over centuries, a few favorites have emerged. Often, says Professor Elvin-Lewis, these are sold in village marketplaces.

"Further," says Elvin-Lewis, "some African tribes take the vines of acacia trees,

strip off the bark, pound them with water, and soak them to make sponges. When they chew this fibrous material, it's very foamy."

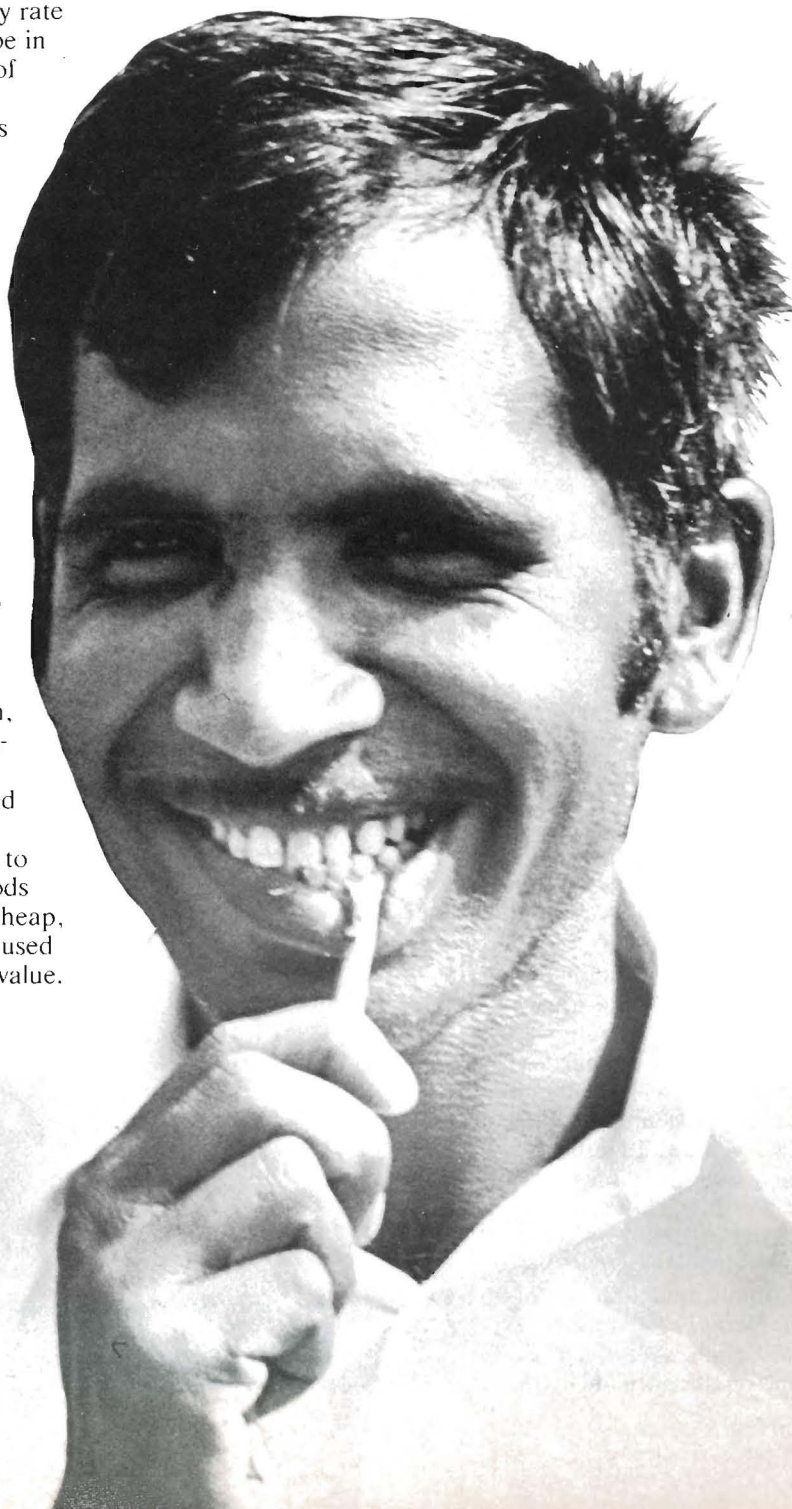
The Lewises believe that the scientific assumption that diet alone is responsible for the low tooth-decay rate among Africans may be in error. "The retention of teeth into adulthood among the populations that use some of these sticks is very high. We suspect that in addition to contributing to hygiene, substances in the sticks themselves may be beneficial."

Marco Polo found toothbrushes in China and introduced them to the Western world. American colonists brought toothbrushes, but found chewing sticks used by Indians, and some colonists seem to have adopted the use. In some isolated areas of the South, says Elvin-Lewis, sassafras, black gum, and sweet gum are still used as chewing sticks.

"One of our goals is to determine what methods and products that are cheap, available, and already used have honest medicinal value.

Only a small number of developed countries have access to modern medical care. But when you begin to research the plants used in traditional medicine, you

realize that a lot of empirical rationale governs people's choices. They've already done the marketing research for us."



Bad Apples

Ronald Feldman, professor of social work, says that rehabilitation programs for antisocial youths that treat offenders as bad apples that need to be culled give recipes for failure. He and other social workers have been testing a new treatment that prescribes mixing bad apples with good. The results show that wayward youths actually act better in mixed company.

"In integrated groups," explains Feldman, "the antisocial children have an opportunity to break from the bad label and learn to improve their behavior through observation and constructive peer pressure."

Feldman's recently completed study followed 200 antisocial youngsters

through a new program that integrates them with prosocial youngsters. Using a program operated by the Jewish Community Centers Association in St. Louis County, Feldman and his co-workers observed their study groups. They mixed 237 antisocial children—ages seven to fifteen and all referred by parents, teachers, and agencies—into groups of exclusively antisocial kids, of prosocial and antisocial, and of exclusively prosocial.

Trained observers recorded the groups' behavior as they engaged in after-school arts and crafts, athletics, hikes, outings, and group discussions. The program was also evaluated by parents, referral agencies, group leaders, and the children themselves.

The results showed that antisocial children behaved

better while in integrated groups, making applesauce of the bad-apple theory of rehabilitation. In fact, a year later, in a follow-up study, these children were able to maintain their improved behavior outside the study setting.

The success of the integrated groups was based on several factors, says Feldman. First, he says, delinquents rarely act alone but in groups in which bad behavior meets with the approval of their peers. But in mixed groups, bad behavior meets with disapproval and eventually changes.

In the mixed environment, the antisocial children were also operating in a healthy social setting, allowing them to correct their behavior in a normal atmosphere on a daily basis. In addition, the treatment center used was not known

as a facility for "bad" children. Exile to such a facility, says Feldman, plays an important role in the single most detrimental barrier a child must face during rehabilitation—stigmatization.

"By virtually any definition," writes Feldman in his book, *St. Louis Conundrum: The Effective Treatment of Antisocial Youths*, "juvenile misbehavior places exorbitant and ever-increasing demands on American society. It imposes a financial burden that exceeds tens of billions of dollars a year. Yet the more telling costs—the physical and emotional tolls that are imposed upon both victims and offenders—are inestimable. Researchers, social workers, and policy makers must work together in order to renew, revitalize and redirect their efforts to deal with this formidable societal problem."

Beyond Basic

The informal collaboration between engineering and medicine that in the past eighteen years consistently resulted in pace-setting research has been made formal by the establishment of an Institute for Biomedical Computing at Washington University. The institute comprises the Computer Systems Laboratory and the Biomedical Computer Laboratory on the medical campus and engineering computing research on the main campus. It will be housed in laboratory space being constructed as a fifth floor of Lopata Hall and named in honor of Edward L. Bowles, a 1920 alumnus and a distinguished

engineering practitioner, educator, and public servant. (An article titled "ELB" appeared in the Winter 1980 edition of the *Washington University Magazine*.)

Throughout the past two decades, Washington University has pioneered in matching computer technology to medicine. The medical computing labs, established in 1964, were among the first to explore the application of the prototype mini-computer to medicine, and their subsequent investigations have often led the field. Today, the research-oriented computing resources developed around

these sister labs represents one of the few biomedical groups whose activities span the entire computing range from formulating mathematical theories and building systems to evaluating performance in research situations. In recent years, joint computer-lab programs have received more funding than any other activity supported by the Biotechnology Research Programs of the National Institutes of Health. The laboratories also attract other major government research funds.

Often, members of the faculty and graduate students in engineering have been partners in this

research, and joint appointments between the schools have become commonplace. Now, the Schools of Engineering and Applied Science and Medicine will jointly govern the institute.

Current institute research involves custom-built microcircuits or chips that can store and process massive amounts of information, advanced computer-generated graphics and modeling, new methods for storing and accessing databases, advanced methods for studying radioactive tracers in the body, and the use of ultrasound for quantitative analysis of living tissue.

S C A P E



GOATS

By Charles Koltz



Lillian Weger of Washington University's Child Guidance Clinic calls the phenomenon of the scapegoat humanity's "psychological blotter." Indeed, the scapegoat's function—to sop up messy guilt, anxiety, and frustration—is as old as human sacrifices, as universal as passing the buck.

As such, the scapegoat serves a necessary if distasteful purpose: It's a mild cathartic to the system.

The purge created by placing all blame on one person, group, or thing can establish balance in an unstable environment and inspire solidarity among conflicting social forces. For example, Nazi leader Hermann Rauschning once said, "If the Jew did not exist, we should have to invent him."

Such a stunning admission was rare insight coming from the ranks of history's most notorious scapegoaters—especially considering the irony of such Nazi hate slogans as "The Jews are our misfortune." In fact, without the Jews to kick around the Nazis would have possessed no equilibrium, no "anti-people" or pariah group upon which to focus blame, dredging from the depths of hatred a witch-hunting unity of purpose.

In much the same way, scapegoaters today hang the leper's bell on many innocent bystanders in many different contexts by means of an illogical turn of phrase or an unconscious psychological juggling act. Prejudices bubble to the surface; wars erupt; children suffer abuse; assassins strike: all because of the painful spasms caused by the social body trying to catch its balance.

According to Sir James Frazer in his famous book about religious rituals titled *The Golden Bough*, the scapegoat originated as a spiritual function "to effect a clearance of all the ills that have been infesting a people."

The ancient Jews held such a ceremony on the Day of Atonement. The high priest confessed the sins of his people over the head of a goat, then the goat was allowed to escape into the desert, taking the collective sins with it. "The evil influences are embodied in a visible form or...loaded upon a material medium, which acts as the vehicle to draw them off from the village, people, or town," explains Frazer.

One doesn't have to look hard to find the historical personification of Frazer's religious rituals. There are scapegoated out-groups in practically every society. In Japan, for instance,

the pariah caste was traditionally the Burakumin, who were discriminated against both socially and economically while being dehumanized with such names as "four-legged" and "filth abundant" (charitably translated). Likewise, India had its Untouchables; the Roman Empire its Christians; the Christians, in turn, their witches and heretics; Europe its Gypsies and Jews; America its blacks and immigrants; and so on.

One social psychologist calls such scapegoating "expressive exploitation"—picking out a convenient whipping person or group to act as your Jonah or Billy Budd.

Psychologists label such helter-skelter blame "displaced aggression," when hostility is directed away from the real source of frustration toward other targets that are less threatening. Practitioners of displaced aggression have graduated from the "I'm taking it out on somebody else" school of hard knocks and practice on their spouses, children, dogs, and various kickable inanimate objects.

Washington University's Weger sees a pattern in contemporary scapegoating that might act as a rule of thumb to use while plumbing the many levels of the phenomenon. As a consultant to government social agencies, in her studies of children at the Child Guidance Clinic, during her service as a Girl Scout leader, and as a result of personal observation of adult groups, Weger has noticed that undemocratic groups bring out the need for a scapegoat in all of us.

"I find that there's a greater likelihood for scapegoating," says Weger, "where people who are part of an organization have little control over their own experience—where their feelings and ideas aren't considered."

Weger says that adults in such situations have been "infantilized"—they've had their free will and power siphoned off so they feel helpless before the whims of authority.

The common reaction is for the powerless to divine a scapegoat: someone to take the heat. Blame life's little trials on the paymaster, the secretarial pool, the mailing room or the tax collector.

"You can relate that same pattern to the classroom situation as well," says Weger, who has written on the subject for *Parents* magazine. "When kids are given more say in a classroom situation,

there is also less scapegoating. In fact, this pattern can be extended throughout society."

The data bear out Weger's hypothesis that in a dictatorial environment blame is passed down like a bad seed in a psychological pecking order that demands defenseless lackies at the bottom.

Dale Olweus, in *Aggression in the Schools*, reports that within colonies of rhesus monkeys living in zoos, "It is not unusual for the groups to be ruled by a tyrannical 'dictator.' Mass attacks on animals of low rank (whipping boys) also occur; something that seems to be extremely uncommon among animals living in natural conditions."

Olweus also notes that in 1939 a team under the direction of Kurt Lewin, then professor of child psychology at the University of Iowa, studied groups of ten-year-old students who were divided into three kinds of leadership situations: authoritarian, democratic, and laissez-faire. The study reported that in the authoritarian groups an individual member was often exposed to strong aggressive reactions from other members. Says Olweus: "This phenomenon was interpreted as a manifestation of displaced aggression from the authoritarian, dominant leader to one of the members of the group, who thus became a temporary scapegoat."

Perhaps the most common area for scapegoating is in the home, where dictatorship usually goes unquestioned.

"In the family situation," explains Weger, "it is not all that uncommon for a marital conflict to find expression in a child scapegoat. Instead of attention being focused on the stress between the mother and father in an overt way, the parents will get angry at the child in a covert way. It's safer that way."

In such cases, the parents usually share some deep emotional conflict so threatening to their relationship or their egos that discussion might mean the destruction of the family group, so they pass the buck to a child who becomes the unwitting accomplice in this case of social cover-up.

The selection of a particular child as scapegoat—or the selection of any pariah for that matter—is no random matter.

"Just as a dream condenses a variety of past and present experiences and a variety of emotional feelings," explain sociologists Ezra Vogel and Norman Bell in an article about children used as family scapegoats, "the scapegoat condenses a

variety of social and psychological problems."

For example, tragic accidents and violent events such as assassinations invariably tear an anguished cry for justice from the throats of the public. Such a reaction is a desperate attempt to condense and symbolically wipe out the tragedy by fixing blame.

University of Missouri psychologist Robert Arkin has performed a number of experiments and studies touching on scapegoating, and he says that the need to fix blame under these circumstances depends upon an almost universal belief in a "just world theory." People want to believe in a fair world. Fixing blame, so goes part of this thinking, helps to balance the scales for the helpless victims. The flammable atmosphere following accident or assassination ignites the vigilante impulse in many people; they demand to see the guilty party dangling by a proverbial rope.

The conspiracy theory is one scapegoating reaction in these instances. "There is unwillingness on the part of the public to think that just one crazed person could do it," says Arkin. "It has to be a conspiracy."

For example, the assassinations of John and Robert Kennedy and of Martin Luther King, Jr., seemed like such momentous events in the eyes of the public, according to Arkin, that the possibility of one person pulling the trigger seemed out of sync with their vision of a just world. Their scapegoat, then, assumed the form of an amorphous, evil, and secretive organization of powerful conspirators.

Humanity's constant distrust and resentment of science has conjured up another old ghost—the very same spirit that haunted Copernicus and Galileo—who points a craggy finger at yet another scapegoat: technology.

Samuel Florman, in his book *Blaming Technology, the Irrational Search for Scapegoats*, devotes several hundred pages to humanity's stubborn resistance to change. "Technology threatens to become in the 1980s," says Florman, "what communism was in the 1950s, or even what witchcraft was in Salem in the 1690s—a word so steeped in emotional implication that its very mention drowns out the voice of reason."

Florman explains the technological witch hunt in several ways, including one allusion to technology as a modern phobia similar to fear of flying. He also poses the interesting, though debatable, hypothesis that "technoscapegoating" is simply another



Lillian B. Weger, a psychiatric social worker and instructor at Washington University's Child Guidance Clinic, sees scapegoats as humanity's "psychological blotter." Her study of the phenomenon sends up danger signals.

manifestation of "pastoralism"—an ancient mode of thought opposed to social complexity and change. Pastoralism, of course, found recent practitioners among the hippies of the 1960s and 1970s.

In any case, fear of technology has loaded the gun for those previously defenseless bureaucrats who would like to discharge all frustrations and incompetencies into the etherized body of an all-purpose excuse. Now, by citing "computer error" as their cosmic response to all criticism, bureaucratic Ahabs have located their Moby Dick.

Social scientist Ruth Eisler posits yet one more scapegoating situation that is rarely considered in that context. She asserts in her article "Scapegoats of Society" that millions of people receive vicarious satisfaction from seeing criminals punished. As evidence she points to the preponderance of criminal activity covered in great detail by radio and television newscasts, newspapers, magazines, books, and other forms of communication.

Her argument is hard to refute. "For society in general, there remains only one justifiable outlet for aggression which can be rationalized on the basis of morality and which can provide the desired relief by externalizing inner conflicts without creating conscious guilt feelings. This is the persecution of the wicked, the criminals, that group of individuals who commit violence, who break the laws, and who do not conform to the demands of society."

Eisler's statement seems true as far as it goes. But what it doesn't say is that a criminal by any other name can be created by the use of reverse-public relations, as we saw during the McCarthy era. Here was the flagrant use of criminality by association. And it is a device often used for political manipulation.

"Since the beginnings of time," says Gerhart Saenger, in the *Social Psychology of Prejudice*, "governments have tended to divert public

discontent, resulting from their own inability to solve their nation's problems, toward minority groups."

One spinoff from such manipulation is displacing blame to other countries or ideologies—a verbal double-reverse that sometimes leads to wars and often allows governments running room for their unsuccessful policies. The University of Missouri's Arkin sees such tactics as an effort to reestablish internal unity in a discombobulated state.

"When you look at the way the Reagan administration characterizes external threats," says Arkin as one example, "you realize that such threats are presented as being much more frightening when there is internal disarray."

"And I think that all this stuff about the Soviet Union and nuclear-arms buildups is a reflection of our government using this tactic."

Arkin, in fact, cites statistics that belie the same kind of "them against us" huckstering. During the 1930s, when economic conditions roughly paralleled those of today, the number of states that required loyalty oaths suddenly jumped from eight to seventeen. And at the same time, despite plummeting crime rates, police budgets around the country rose collectively by 15 percent. In other words, every state must have its Joan of Arc; every city its Judas to hang.

Where else can we look for manifestations of scapegoating?

Aggression in the stands during athletic events might give us some insight into man's inhumanity to scapegoats. "Kill the ump!" has become much more than an idle threat.

A Reggie Jackson pelted with debris; a football referee conked with a liquor bottle; a Dave Parker harassed with death threats; and a boxing riot at Madison Square Garden, do not necessarily trumpet a new age of anarchy. After all, the original Olympics eventually were cancelled on account of bellicose crowds, and during one three-day festival of Roman chariot races, 30,000 spectators died.

But such turmoil suggests that something is, indeed, rotten in the state of landmarks. The natives, as they say, are restless.



One of the causes, write Bill Gilbert and Lisa Twyman in a recent *Sports Illustrated* story, is the excessive team identification that clubs consciously inspire in their fans, along with the obligatory



"Winning is everything!" battle cry.

But there is more to wild behavior than meets the billy club or the teeth of security dogs. As Washington University's Weger observes, the scapegoating action, by its very nature, is the consequence of some other repressed problem. What we are witnessing here is not a scapegoater's problem, but a warped solution.

"More and more people aren't making it," comments sociologist Irving Goldaber in that same article. "You work hard, you exist, but you haven't got much to show for it. There are increasing numbers of people who are deeply frustrated because they feel they have very little power over their lives. They come to sporting events to experience, vicariously, a sense of power."

Goldaber's "everyfan" also characterizes that most chilling scapegoater of all. It invokes images of the blank face in the crowd, his eyes guarded by dark glasses, his coat bulging with the heavy, numb weight of a Saturday-night special. Goldaber's characterization bears witness to the lost soul who waited all his life for one turn to point the deadly finger of God; one chance to play the central role of high priest sacrificing our ultimate scapegoat.

Are not the demented John Hinckleys of this world the exceptions who prove the rule? Their iconoclastic, tortured acts should teach us one basic lesson about scapegoats. If our public figures play our fears into war, direct our insecurities into hatred, displace our ills with prejudice, steer our loyalties into unquestioning aggression, can we then be surprised when the deranged outcasts slash back and return to haunt us in like manner?

"The fault, dear Brutus, is not in our stars, but in ourselves...."

Hyperthermia

By Don Clayton

As early as 2000 B.C., healers reported suspicions that heat could cause tumors to shrink. Now at Washington University School of Medicine, two physicians and a physicist are applying new technology to prove ancient suspicions true. In the Hyperthermia Research and Treatment Center, heat therapy has become state of the healing art.

Gilbert H. Nussbaum, Ph.D., used to spend his time in an accelerator laboratory, smashing atoms and molecules together like ivory balls on a billiard table to study the effects of high-speed collisions. In the decade after his doctoral education at Harvard University, he had managed to earn academic tenure and the respect of his colleagues in the field of atomic physics.

But Nussbaum bailed out. "It was just more of the same stuff from one experiment to another. The results ceased to matter very much to me," he says.

After a turbulent ride in the winds of redirection, Nussbaum's chute opened and set him gently down on new scientific turf: the world of medical physics. After a sabbatical year at M.D. Anderson Hospital and Tumor Institute in Houston, the die was cast. There he studied the physics of radiation medicine and changed from smashing atoms to shrinking tumors, a change as radical as a marathon runner switching to the dash.

In 1980, just a few years later, Nussbaum came to Washington University School of Medicine to work with Carlos Perez, M.D., director of the division of radiation oncology. Perez and Nussbaum had a common interest and background in hyperthermia therapy, the use of heat to shrink cancerous tumors.

Both would be embarrassed to be described as scientists broaching new frontiers or as researchers rolling back the boundary between speculation and fact. To them their work seems nothing so romantic. Yet there is no denying that hyperthermia therapy for cancer victims is a frontier-like discipline that in gaining momentum is sucking curious scientists into its tail wind.

"Hyperthermia is definitely going somewhere," says Nussbaum, implying that part of its appeal for him is the

sense of progress he has felt since he began research on therapeutic heating of malignant tissue.

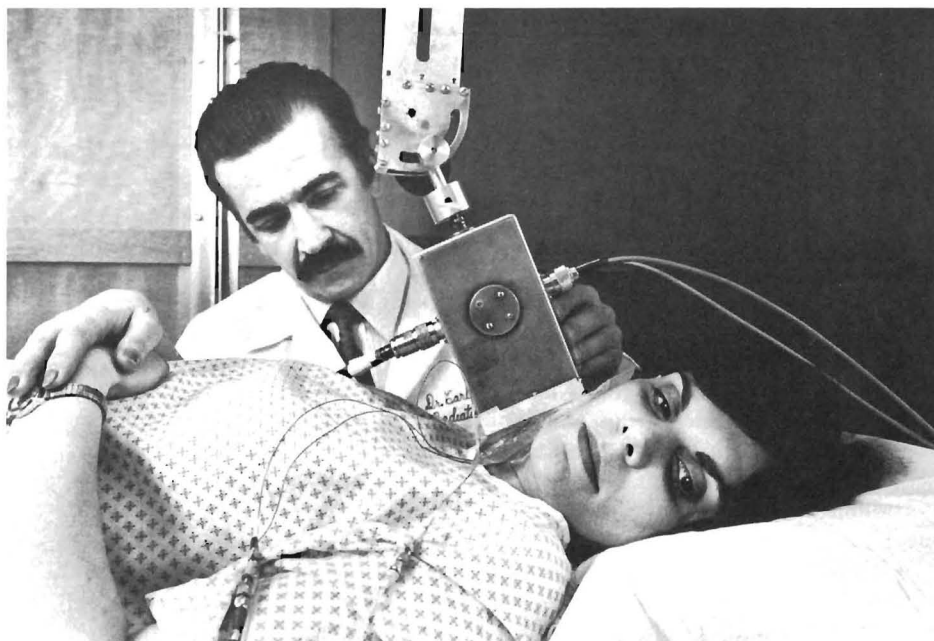
"Before you can understand where hyperthermia is going, it is useful to see where it has come from," says Bahman Emami, a physician involved in hyperthermia research since his post-doctoral work more than six years ago. He joined Washington University in 1981 a year after Nussbaum. Under Perez's leadership, Emami and Nussbaum have become the driving force of the University's hyperthermia research.

"This is not a science without a history," Emami explains. "As far back as 2000 B.C., healers have reported on the beneficial effects of elevated body temperature. In 400 B.C., Hippocrates himself told of the shrinkage or disappearance of tumors that had been heated with red-hot irons." Much later in history, during that period in the 1800s when medicine was beginning to acquire the characteristics of science we associate with it today, a German physician named Bush reported that a patient's facial tumor disappeared after two attacks of high fever caused by a bacterial infection. Bush postulated that the high fever caused the tumor remission.

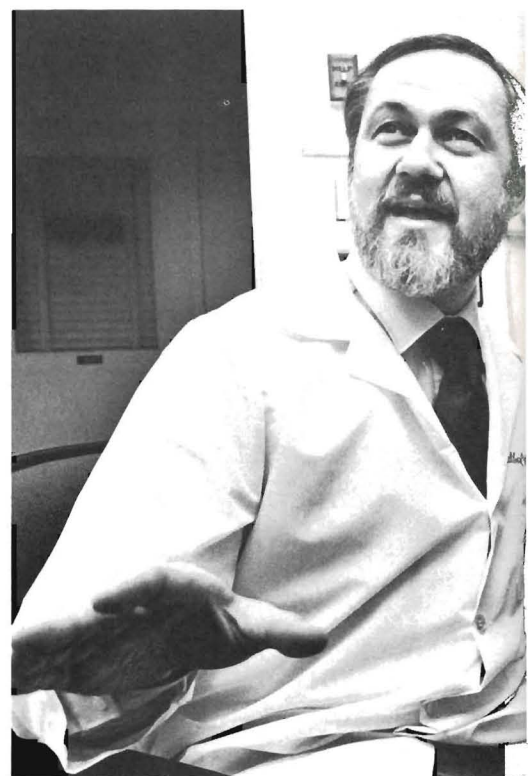
The turn of the century marked a fair amount of research on the generation and application of heat for therapeutic purposes. However, a faddish interest in hyperthermia resulted in several unfortunate episodes of quackery. Some cancer patients were treated by being exposed to bacterial agents in the hope that a high fever would develop. Others were subjected to a variety of questionable methods of heating the body from the outside.

"I have seen reports written by one therapist who asked his cancer patients to rest beneath infrared lights like the ones now used to keep hamburgers warm at McDonalds," Emami says. "Several other ineffective methods of heating were also used."

Hyperthermia



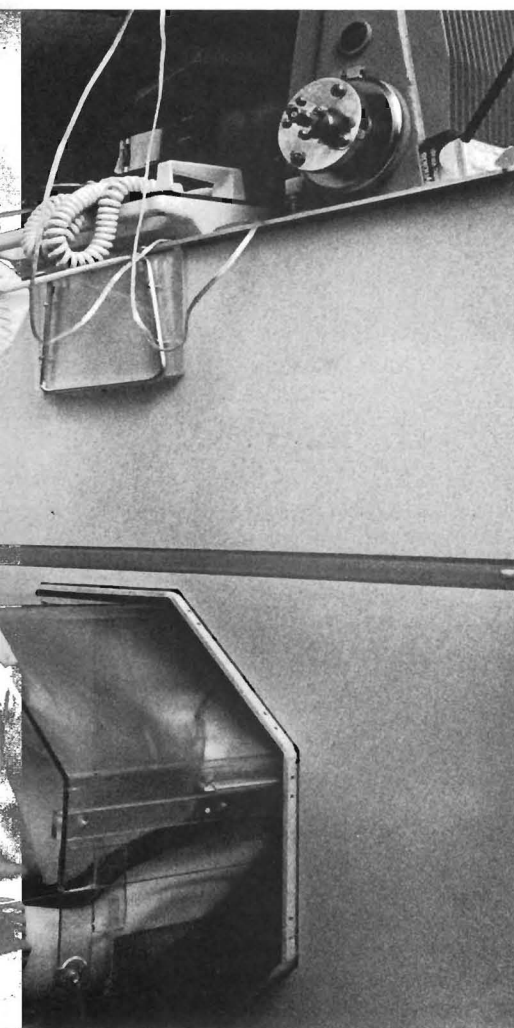
Perez, in final preparation for a local hyperthermia treatment, checks the positioning of the rectangular heat generator against a plastic bag filled with deionized water. The water bag serves as a coupling agent between the tumor and the heat source and helps to limit undesired heating. For this treatment, temperature will be monitored at three locations: wire-like extensions of thermometers can be seen crossing patient's left shoulder.



Nussbaum and Perez prepare patient for deep regional hyperthermia. The heating of tumors deep within the body is accomplished by surrounding the patient with four large microwave generators. The clear plastic octagonal treatment couch, designed by Nussbaum, improves the precision of the heating and provides additional safety for the patient.



Nussbaum at the computer console during an actual treatment. The computer monitors temperatures at up to eight points throughout the heated tissue and is sometimes used to control the temperature at a critical location. Tumor temperatures are displayed on the screen at right.



Legitimate physicians, whose interest in hyperthermia waned, strongly advised quacks to stop treating patients. "At the same time," says Perez, "new cancer therapies—particularly radiation therapy—were becoming more and more successful." Hyperthermia research dwindled and nearly died. In the first seventy years of this century, few scientists continued to study it, and few useful reports were published.

"But in the last ten years," Perez says, "Technology has brought significant advancement in two areas: thermometry and heat generation. Using sound waves and microwaves as heat sources, we have been able to raise tumor temperatures more effectively. New thermometers as small as hypodermic needles can be inserted into the tumor to measure temperature elevation during therapy."

The technological boom presented a mother lode of research opportunities in hyperthermia. "The field is very exciting and wide open. There is considerable opportunity for interesting research and a definite promise of reward for ingenuity," says Nussbaum.

"I would say it is exploding," resounds Emami.

"We have come a long way since Gil Nussbaum and Bahman Emami joined us," confides Perez, smiling as he recalls how humbly hyperthermia research began at Washington University. "I started the program in 1978 on a small scale, in one room on the ground floor of the Mallinckrodt Institute of Radiology. Like hyperthermia research at several other universities, work here began with patients who had tumors on the very surface of the body. We started treating visible or palpable tumors that could be reached easily.

"The first heat treatments were given with a diathermy microwave generator, which we borrowed from the physical therapy department. It was not designed

to treat cancer patients, but we modified it somewhat and found we could use it to heat tumors. Even with that kind of equipment, our first results were quite encouraging."

Perez presented those results to Ronald G. Evans, M.D., director of the Mallinckrodt Institute, and quickly received departmental approval and support to expand the staff, space, and equipment relegated to hyperthermia research.

The new space included laboratory and treatment rooms on the sixth floor of the Barnard Free Skin and Cancer Hospital. Emami and Perez, both clinical staff members of Barnes Hospital, coordinate the treatment of cancer patients at the Hyperthermia Treatment and Research Center. They also work together to develop standardized protocols—blueprints for therapy—to provide more objective evaluation of treatment regimens.

Nussbaum, meanwhile, has used his physics background to evaluate methods of depositing heat in living tissue and to compare the performance of various commercially available devices designed to generate heat. Several commercial applicators were adapted for use in clinical hyperthermia, and a number of heat applicators were designed and fabricated in-house. "Some of the equipment was essentially built from the ground up," he says.

In 1982, Perez presented data on 101 cancer patients treated at the center. Using their own protocols and equipment, the three researchers found that heat therapy used in conjunction with radiation therapy had effected some degree of tumor regression in about 80 percent of the patients suffering from certain types of cancer who came to the center. In several test subjects the tumor disappeared completely and, at last check-up, had not returned.

"I can remember one patient," says Nussbaum, "who had a tumor as big as

Hyperthermia

an orange on the side of his neck. The heat therapy had a tremendous effect; we could see improvement with each treatment."

"These tumors were of many different types and sizes, but all were still relatively close to the surface of the skin," says Perez. However, "the results were even more impressive than those we received earlier with the simple diathermy applicator. We have advanced now to the point that combined thermotherapy and radiation therapy can be used with optimism in the treatment of breast cancer, cancer of the head and neck, and skin cancer. In some cases it can be used in tumors that have spread to the lymph nodes."

Emami says it is important to realize that the 80 percent success rate, although confined to certain cancers, was achieved with patients on whom other forms of therapy had proved ineffective. These tumors had not responded to chemotherapy or radiation therapy alone. "These results are now being repeated regularly here and at other research units across the nation. That's why I say the field is exploding. We've got to keep driving forward."

"Obviously," says Nussbaum, "the next step is to see what will happen if we try to heat tumors located deep within the body. The major questions here are whether we can heat the malignant tissue, spare the normal tissue, and document satisfactorily what we have done."

Physicists and engineers have long studied the mechanisms of heat deposition and heat transfer in gases, liquids, and solids, but these studies are of limited value in predicting temperature distributions in human tissues heated with microwaves, radio frequency currents, or ultrasound. "Think about it," says Nussbaum. "When you shift your attention from heating superficial tumors to heating tumors deep in the pelvis, you are



In the operating room Emami and two assistants introduce supple hollow tubes into the patient's tumor. Following this surgical procedure, thermotherapy will be administered in the hyperthermia treatment center. Small microwave antennae inserted into the tubes produce the desired heating. The tubes, painless once installed, remain in place throughout several hyperthermia and radiation treatments.

grappling with a monstrous problem. But you have also identified one truly interesting area for research.

"Our ability to deposit heat will depend, for a particular arrangement of heat applicators and set of operating conditions, on the electrical and acoustical properties of the medium. The resulting temperature distribution will depend critically on the medium's thermal and physiological properties. The body is a very inhomogeneous medium. Electrical, acoustical, thermal, and physiological properties are all subject to substantial variations. Moreover, some physiological properties—for example, the rate of blood flow—change with tissue temperature. Therefore, to predict temperatures at various points during therapeutic heating is, at best, extremely difficult."

"In the end," says Emami, "it's going to come down to whether or not we can successfully circumvent the system of temperature regulation that thousands of years of evolution have built into the human body. Our goal is to elevate the temperature of the tumor to 110° to 114°, while keeping the patient's core temperature, or fever, below 104°."

"Temperatures of about 110° take a high toll on cancer cells," says Perez. "We have found that previously irradiated tumors are more susceptible to heat than normal tissues. Heat and radiation work very well together." Radiation, which inflicts heavy damage on cells rich in oxygen and reproducing rapidly, works most effectively against peripheral tumor cells. Conversely, heat therapy seems to devastate the tumor's core cells, which are poorly oxygenated, malnourished, slow to grow, and suffering from acid-base imbalance.

"Tumors are a testimonial to survival," says Nussbaum. "The tumor grows its own network of capillaries to siphon oxygen and nutrients from the bloodstream. Typically, these capillaries service only the cells relatively close

to the surface of the tumor, leaving the interior cells in an oxygen-starved, nutritionally deprived state." Emami and Nussbaum have shown experimentally that heat can have a direct effect on those all-important capillaries.

"Consider the capillaries as a lifeline serving the tumor," Emami explains. "Using a noninvasive technique we developed for measuring blood flow in tumors, we compared that flow in certain animal tumors before and after heating. We found that for the levels of heating employed in clinical hyperthermia, the circulation after heating was substantially and permanently reduced—an indication that the lifeline was seriously damaged. It's like destroying the railroad tracks that move cargo in and out of the tumor."

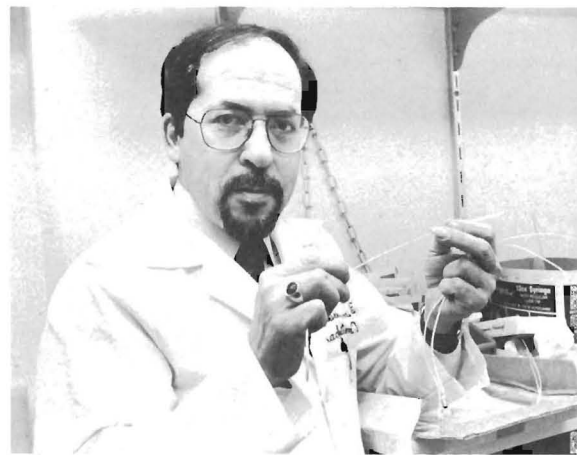
The equipment used to treat tumors deep within the body is several degrees more complicated than that used for tumors near the surface. Not unexpectedly, the ubiquitous computer can be found in the treatment room at the hyperthermia center. Last year the center obtained an elaborate computerized device designed to produce therapeutic heating deep in the body.

"This unit will permit deep heating of the pelvis, abdomen, and lung," says Emami, who has developed a protocol for its use. This protocol will most likely be implemented on a national scale to guide researchers at other medical institutions treating deep-seated tumors with hyperthermia.

Looking somewhat like a small CAT scanner, the unit surrounds the patient with four large microwave applicators. During the treatment, temperatures are monitored at up to eight different locations within the body. The computer continuously samples and displays these temperatures throughout treatment.

"We have treated nine patients so far," says Emami. "The University of Utah is the only institution that has more experience than we do with this device.

Plastic tubes, installed in the tumor and surrounding tissues, serve as tunnels into which the physician can insert thermometers, tiny microwave generators, or the radioactive substances used during combined hyperthermia and radiation therapy. Emami examines a tube that will later be implanted.



But, for both institutions, it's too early to judge the effectiveness of this approach."

To provide adequate space for the influx of patients with deep-seated tumors, the hyperthermia center is moving to new quarters. The patient-treatment area will expand from the cramped sixth-floor rooms to a large, recently redesigned portion of the third floor of Barnard Free Skin and Cancer Hospital. The new space will include three new treatment rooms, two using microwaves and a third using ultrasound as a heat source. Examining, conference, and reception areas are also being built.

Cancer research often seems to inch along at a snail's pace as researchers examine theories which look promising but hold no guarantees. Hyperthermia stands out as an agent of definite clinical potential. However, a good deal of work remains before this potential can be fully realized. Nonetheless, current results at Washington University clearly promise that hyperthermia will have a significant effect on cancer treatment.

"I am an optimist," says Emami. "Yet there is still much we have to learn. In the final analysis, the effectiveness of clinical hyperthermia will depend simply on this: To what extent can we heat tumors and spare normal tissues from thermal injury?"

ARCHES

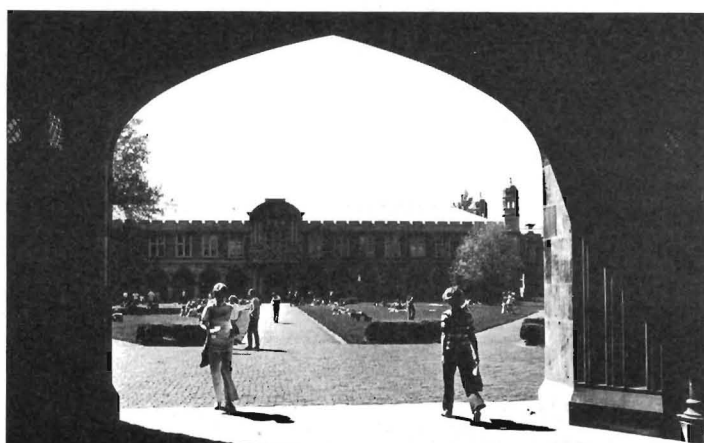


Brookings's central Tudor arch is from the west the gateway from campus to community.

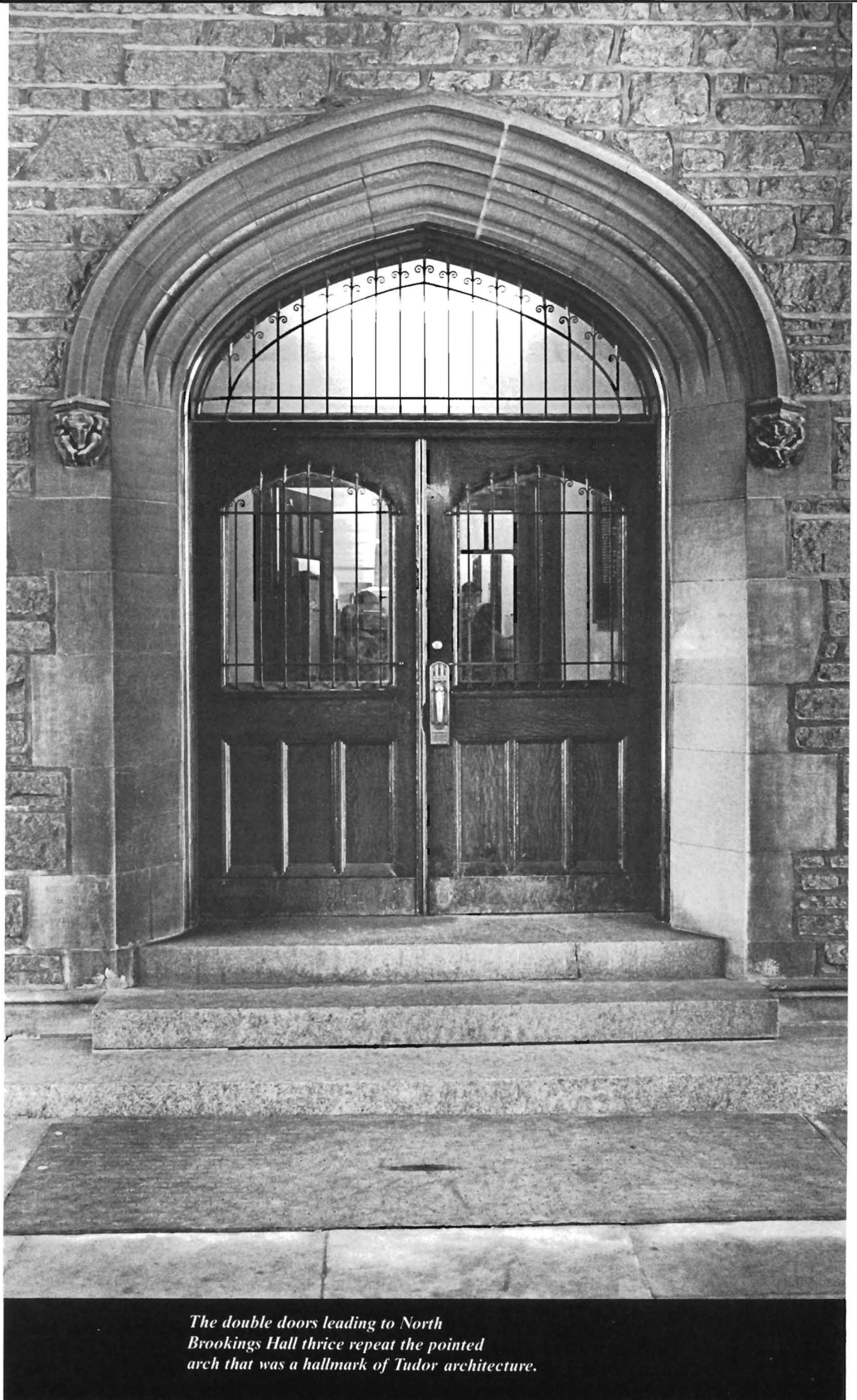
Few college or university campuses in the United States stamp in alumni memory so strong a sense of place as Washington University. The beauty and integral grace of the campus is one of its enduring features. As Herb Weitman's camera annotates, arches are a central theme of the Hilltop's Tudor Gothic architecture. They are a contour of education at Washington University.



From the east, the Brookings arch is the campus's front door opening at the top of the long stairs onto the main quadrangle.



One of the wonders of the campus's architecture is how it changes with the seasons' light levels. The dark archway of winter comes alive with detail in spring's sunlight.



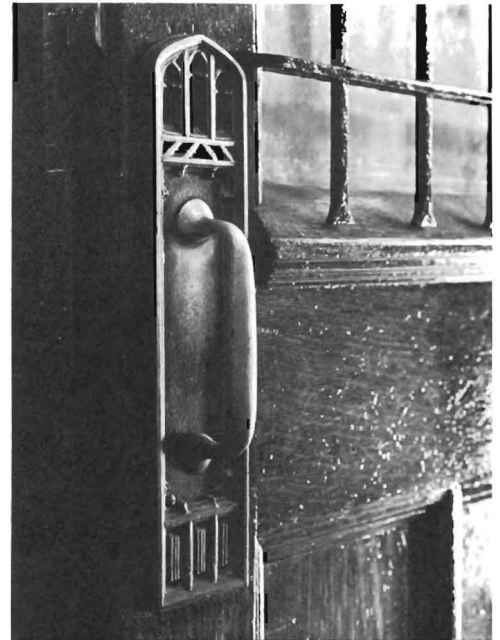
The double doors leading to North Brookings Hall thrice repeat the pointed arch that was a hallmark of Tudor architecture.

ARCHES

The University's arches frame endless vistas, they shape doorways, they are repeated ever smaller in architectural detail. That sense of quiet elegance and orderliness pervades the experience of students of the class of 1985 as it did the class of 1905, when the first buildings, leased to the St. Louis World's Fair, were returned for University occupancy.



The back door of Graham Chapel, though stark and utilitarian compared to the Chapel's massive front doors, still plays upon the Tudor arch and Gothic stone detail.



The brass doorplates and pulls on many original campus buildings set keystone arches inside the overall pointed arch.

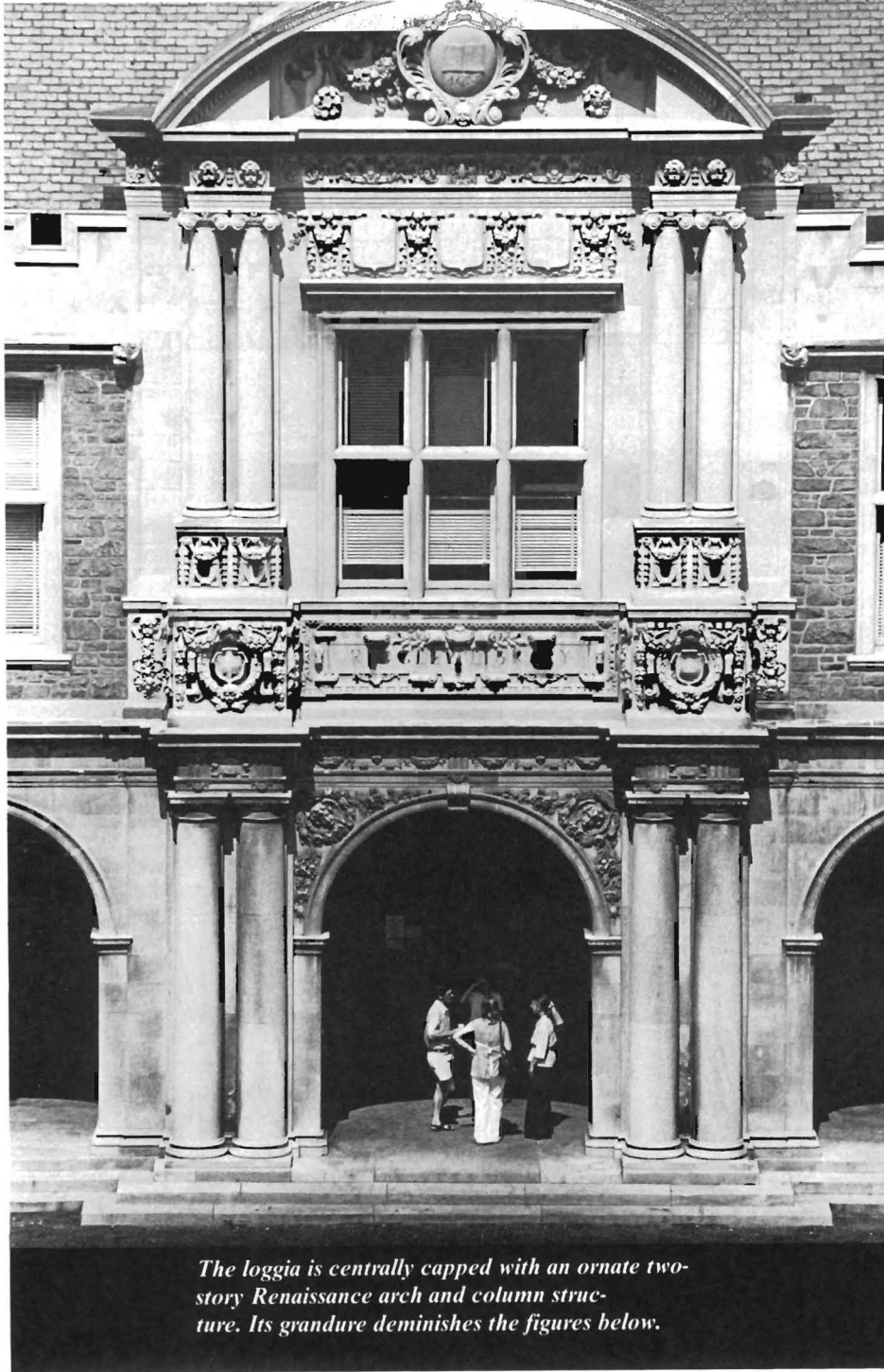


The University's craftsmen called upon to fashion decorative imposts for the arches often did so with playfulness. A wooden figure of a woman next to a Chapel organ pipe holds her ears.

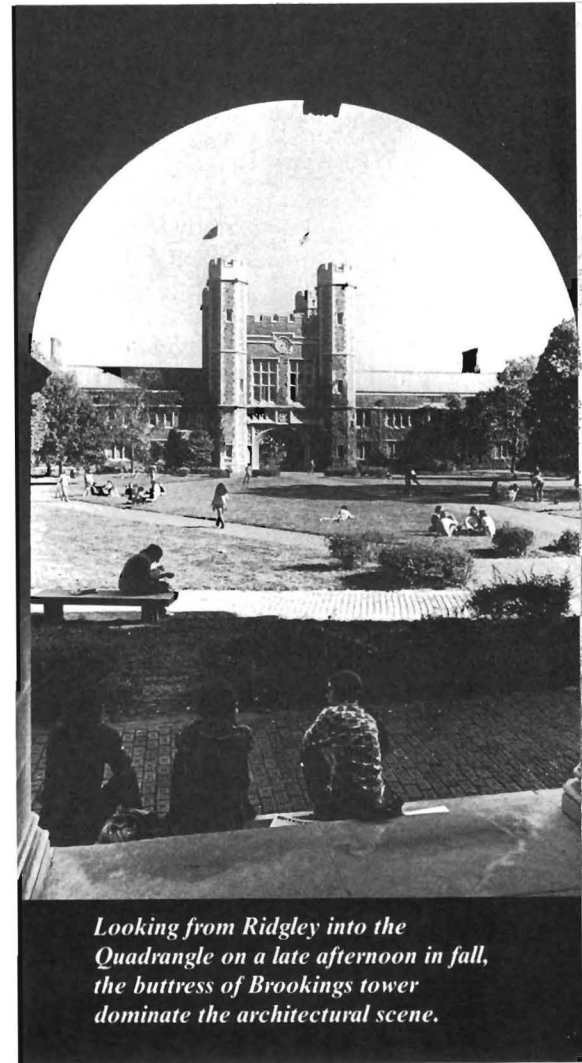
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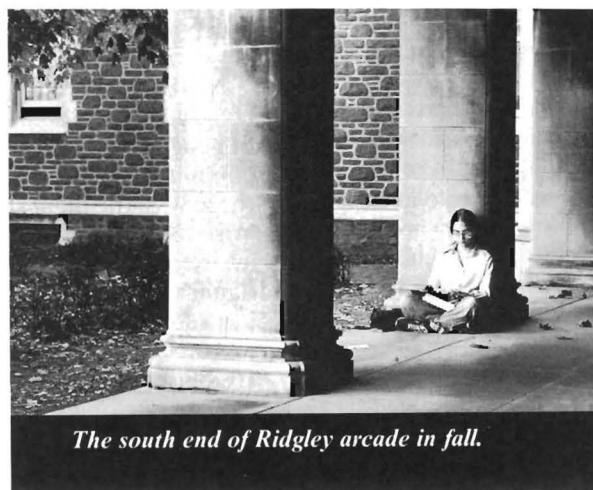
The arch and architecture on the west side of the main quadrangle change from Gothic to Renaissance. The taller and slimmer rounded arches of Ridgley form a loggia.



The loggia is centrally capped with an ornate two-story Renaissance arch and column structure. Its grandure diminishes the figures below.



Looking from Ridgley into the Quadrangle on a late afternoon in fall, the buttress of Brookings tower dominate the architectural scene.



The south end of Ridgley arcade in fall.

CAPITOL LIABILITY: SUBCOMMITTEES



Kenneth A. Shepsle, professor of political science, was only half jesting recently when he told Monsanto Company executives, "The opposite of *progress* is *Congress*!" And the papers that Shepsle and Washington University economist Barry Weingast have produced through the University's Center for the Study of American Business that elaborate on this belief, pull no punches.

In their most recent booklet, *Public Policy Excesses: Government by Congressional Subcommittee*, which also carries the byline of Clifford M. Hardin, former director of the center and now a scholar in residence, they state unequivocally, "The basic causes (of our nation's ills) rest with Congress.... During the decade of the 1970s, a collection of powerful subcommittees—about 150 in each house of the Congress—provided the drive for much of the unrestrained and uncoordinated growth of the federal establishment."

Although the Shepsle-Weingast collaboration recently produced a spate of papers, most targeted for a wide audience in business, government, and academia, such collaboration is not new to Shepsle. No fewer than twelve of the articles he has published and two of the four books he has written or edited since 1970 are joint efforts. In the years since he earned the doctoral degree from the University of Rochester, he has teamed up with many fellow political scientists, including the University's Robert H. Salisbury, the Sidney W. Souers Professor of Government.

While the working relationship between this political scientist and this economist is not as rare as confirmed sightings of UFOs, interdisciplinary collaboration is definitely uncommon in the academic community, Shepsle observes. "The language barrier that divides disciplines is at least as effective as the separate buildings in which they are normally situated."

What these young scholars (Shepsle at thirty-seven is seven years Weingast's senior) are focusing on is how politicians organize political institutions, and what consequences this structuring has on public policy. In zeroing in on this, they have concentrated on the legislative branch of government.

Shepsle, who grew up in Washington, D.C., and has studied Capitol Hill intermittently throughout his thirteen years at Washington University, is the pair's senior Congress-watcher, but theirs is a

partnership of equal input influenced by their respective fields. Each has the view of a specialist, but one tempered by an intensive exposure to the other's discipline. Shepsle's dissertation dealt with economic forces in campaigns and elections and Weingast's with the political economy of safety regulation. In their fundamental view of Congress they totally agree.

In their report on public policy excesses, they link government-by-subcommittee to excesses in the fiscal, credit, and regulatory realms and conclude "executive bureaus appear 'runaway' and federal spending 'uncontrollable,' because Congress made them that way." They warn: "The major policy implication of this conclusion is that proposals to resolve these problems that do not place responsibility in the Congress itself are doomed to failure."

Hardin, the major catalyst for this and other papers published recently for lay audiences, helped persuade Shepsle and Weingast to write not only for their peers, but also for a broader spectrum of the population. This suggestion, coupled with some gentle prodding from a University trustee who asked Shepsle, "Why don't you guys ever write things for average people?" prompted Shepsle and Weingast to compose in the vernacular.

Neither finds it easy. "In writing for our academic peers," Shepsle explains, "the language barrier isn't completely inhibiting." But translating jargon into prose that an intelligent reader can understand is far more difficult, they say. Yet Shepsle stresses, "It's really fun to write for other people and satisfying to feel, if only vicariously, that your ideas are getting into the public arena."

Neither researcher shies away from controversy. "Legislators are bound to their districts by the tugs of geography," they maintain, "and congressional committees and subcommittees are populated by those with the highest stake in a given jurisdiction." Wise executive agency heads, they contend, are aware of this and know they cannot survive if they flaunt the wishes of those congressmen who have jurisdiction over their work. Shepsle and Weingast reason: "Congress has been eclipsed not by the Executive Branch, but by its own subunits. The decline of Congress is, in fact, the rise of government by (sub) committee. Congress has lost the capacity for self-discipline. It has destroyed its institutions of self-regulation." To state their thesis

Political scientist Kenneth Shepsle, who joined the University's faculty in 1970, contends that legislature by subcommittee is a capitol liability leading to uncoordinated federal growth. He and colleagues here focus political science's newest tool, mathematical modeling, on their theses to bring to them some degree of scientific logic.



in yet another way, they enlist Pogo's exclamation, "We has met the enemy, and they is us!"

The author's humor surfaces often in writing and talking of collaboration. "We have a standard joke," Shepsle explains. "Whenever one is critical of the other's work, the victim says, 'Well, I'm glad my ego wasn't involved in that one!'" Perhaps the problems and joys of joint creators were best set forth in Shepsle's first book, written with Alvin Rabushka, senior fellow at Hoover Institution of War, Revolution, and Peace. In its acknowledgements, they said, "Any errors of fact or interpretation must, in a co-authored project, be the fault of the other guy."

Shepsle spices his writing with quotations—many good for a chuckle. Discussing congressional party leadership in *The Giant Jigsaw Puzzle*, he

included a facetious poem by an anonymous congressman to make a salient point about the power wielded by the late Sam Rayburn. It read: "I love Speaker Rayburn, his heart is so warm, And if I love him he'll do me no harm. So I shan't sass the Speaker one little bitty, And then I'll wind up on a major committee."

Shepsle's office is walled on one side by books, and his publications and conversation leave little doubt that he has read many of them. His catholic tastes range from the *Congressional Record* to science fiction writer Robert Heinlein, who reportedly caricatured a legislature as "a body with no head and one hundred bellies."

Shepsle's inexhaustible supply of anecdotes buttresses his arguments. In discussing the reciprocity between congressional subcommittees

This spring, Shepsle received a Guggenheim Fellowship to support a year of research.



—the practice that operates on the premise, “You give me monopoly authority over policy in my jurisdiction, and I’ll do the same for you”—Shepsle noted a disaster that befell James L. Buckley, former senator from New York. In 1969, Buckley introduced fifty amendments to the quintessential pork barrel act—the omnibus rivers and harbors bill. Each amendment deleted a public project from one state. Forty-nine of the fifty were defeated. Shepsle inquires, “Any guesses as to which one passed? The Public Works Committee and the entire Senate supported one cut—a water project from New York State—leading *The New York Times* to editorialize ‘Why is it that New York is the only state with but one senator?’”

The pork barrel, as applied to water project bills, is a special interest of Shepsle and Weingast. In September 1981, they received a two-year National Science Foundation Grant for “Research on the Political Economy of the Pork Barrel” and are now applying for a two-year extension.

Meanwhile, they are conducting a study of the 1982 election’s effects on public policy toward American business. They plan to publish these findings this spring. “But,” Shepsle cautioned, “that’s still ‘iffy’ because professors don’t work on assembly lines.” In this paper, they argue that the media missed the real meaning of the election because they focused on the party composition of the whole Congress rather than on the effect of individual defeats and victories on committees and subcommittees.

Attrition—by election, resignation, or death—can have dramatic impact on specific public policies, even though it may have only a small effect on total congressional composition. Consider the Armed Services Committee of the Senate. Harry F. Byrd, Jr., a Democrat from Virginia, retired, and Howard W. Cannon of Nevada was defeated. As a consequence, two more junior Democrats, Sam Nunn of Georgia and Gary Hart of Colorado, moved up in the committee pecking order. “Neither is a ‘dove,’ but each has been, in various ways, a strong critic of the U.S. Department of Defense,” according to Shepsle. “The bottom line for Caspar W. Weinberger, secretary of defense, is that he is going to be in for a pretty rocky road the next two years. Some defense contractors also may have problems even though there was ‘no change’ in the total party

make-up of the Senate,” Shepsle said.

Crucial to the observations of Shepsle and Weingast is that they flow from scientific logic. Both are ardent proponents of what is called mathematical modeling in the social sciences. Mathematical modeling experts, according to Shepsle, “begin with a set of assumptions built on very precise concepts. We ask what these assumptions imply? Then we use the rules of logic to deduce consequences. With the growing use of formal mathematics, this method occasionally becomes arcane. But instead of emphasizing this, I would emphasize the closer relationship between the concerns of mathematical modeling and those found in the qualitative arguments of political science preceding World War II. Although one uses mathematics and the other plain old English, each is concerned with the logical flow of ideas rather than with quantitative statistical relationships.”

In economics, mathematical modeling has long been accepted as a valid methodology; in political science, it is still controversial. William H. Riker, dean of graduate studies at the University of Rochester, president of the American Political Science Association, and Shepsle’s mentor, is a recognized leader of this movement. Responding to critics of mathematical modeling, he wrote: “To reveal nature, with even a bit of objectivity, ultimately renders prudential judgments wiser, which is why we should at least continue to try to turn some parts of political description into science.”

Washington University’s department of political science, which ranks among the best in the country, has, according to Shepsle, “probably as strong a concentration of mathematical modelers as any other place in the country. That’s one of the things unique about our department. We are among three or four programs in the nation that have sufficient modelers on the faculty to recruit explicitly for graduate students in this area.” He emphasized, however, that the department’s movement in this direction has not come at the expense of qualitative or quantitative political science. “Here we have managed to accommodate all three traditions, and that’s quite an achievement for a department of seventeen or eighteen.”

Shepsle says little about his own achievements, but they are impressively enumerated on his eight-page curriculum vitae. Economist Weingast



1980 meeting of the House Select Committee on Aging convened to investigate charges of politicizing of the White House Conference on Aging.

considers Shepsle one of the “young greats of the political science profession. If you look at scholars of American politics in their late thirties and early forties who are full professors, very productive, and likely to dominate the profession for the next twenty years, you come up with about five or six people. Shepsle is one of these.”

Riker points out that very few scientists in the field are simultaneously theorists and testers of theory. “Kenneth Shepsle is a remarkable exception. He is able to construct intelligent mathematical theory about politics and then to subject it to complicated empirical tests. He did this work on committee assignments in Congress and is now doing it on agenda in legislatures. More important than all of this, however, he is a warm human being, a loyal friend, and a witty companion.”

Recognition of Shepsle’s unusual abilities comes from many sources. He is especially proud of his appointment to the Center for the Study of American Business. He regards as decidedly beneficial its interdisciplinary associations (Shepsle is the only political scientist on its staff), its visiting scholars, and its various research opportunities (travel, half-time teaching to allow more freedom for writing, excellent secretarial and other assistance). He especially appreciates the balance between academic and practical affairs fostered by the center’s director, Murray Weidenbaum, the Edward Mallinckrodt Distinguished University Professor.

Last year, Shepsle attended two European conferences: one in Berlin on broad issues of public policy and another in Britain on “Britain and America: Mutual Lessons in Recent Public Policy.” At the British meeting, some twenty-five delegates lived in the seventeenth-century guest quarters of

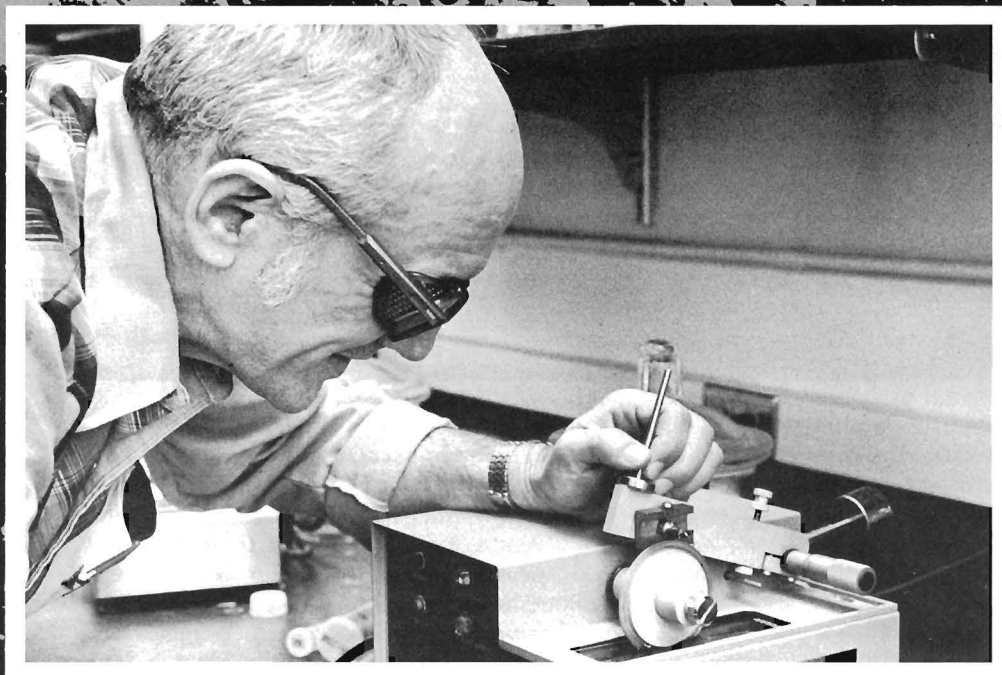
Windsor Castle and met in the Chapter Library where William Shakespeare previewed *The Merry Wives of Windsor*.

Somehow, Shepsle has found time in the past year to coedit with Peter Ordeshook, professor of political science at Carnegie-Mellon University, a book called *Political Equilibrium*. He also shared with Weingast the Duncan Black Prize of the Public Choice Society, an organization in which Shepsle has long been a leader. And in efforts to contribute outside academia, he served as a political consultant for Missouri on the staff of the 1982 News Election Service, a cooperative venture of ABC, NBC, CBS, AP, and UPI, organized to funnel election-night interpretation to the public. Under contract to ABC, Shepsle has been a part of this cooperative effort for every national election since 1976.

A tall, lanky fellow with a penchant for turtle neck sweaters and tweed jackets, he keeps a bulletin board that extends the length of his office, which by no stretch of the tapeline measures up to the adjective *spacious*. “In academe our workplaces are intended to be for solitary confinement; my bulletin board is my distraction,” he explains.

It is decorated with an eclectic assortment of souvenirs including Tar Heel bumper stickers (he completed undergraduate studies at the University of North Carolina), a menu from a posh British restaurant, the usual family photographs, and a neon-bright self-portrait of a bearded, bespectacled Chicago artist.

Always close at hand are his typewriter and the *Washington Post*, which he devours daily. He explains, “It does an outstanding job of covering the two things that are important to me—congressional politics and Atlantic Coast Conference basketball.”



MINING the MOON

By Charles Koltz

Professor Larry Haskin (at left), chairman of Earth and planetary sciences, and colleague David Lindstrom might have been said to be moonlighting from their more serious study of Earth and Moon rock composition when they dipped into applied space technology. But the result is a technique for mining from the moon some of the raw materials needed to build in space.

Two researchers at Washington University in St. Louis are bringing some of the speculation about colonizing the "high frontier" of space down to earth by testing a method of easily obtaining raw materials from the moon. Larry Haskin and David Lindstrom—fellows at the University's McDonnell Center for Space Sciences—have shown in the laboratory that you can take ordinary lunar soil and, using electrolysis, separate from it iron, titanium, silicon, and oxygen.

The importance of their research—the first of its kind applying electrolysis to simulated moon rock—is to demonstrate that mining Earth's sister planet can supply cheap and efficient raw material for use in space.

"It only takes about 5 percent as much energy," says Haskin, "to lift a given mass of material off the lunar surface and put it into orbit as to lift it off Earth's surface. "Therefore, we have attempted to make some preliminary examinations of what some day might become an appropriate

technology for getting raw materials from lunar rocks while at the same time taking advantage of things that are naturally present in the lunar environment and not requiring a lot of material to be taken from Earth."

A glowing advantage of the new process is that the lone source of energy needed on the Moon is sunlight. An array of solar collectors the size of a football field, Haskin and Lindstrom estimate, could supply enough energy to produce a ton of iron every 24 hours. Haskin predicts that earthlings will want to begin operations using various mining technologies on the Moon by the year 2000.

Raw materials in space will be put to numerous uses and orbit around three themes: isolating humans from the hostile environment of space, creating life-support systems, and building mechanisms for collecting and distributing energy.

For some time, scientists have been speculating about the best ways to obtain raw materials for settling the floating outback beyond our atmosphere. At first glance, Earth resources seem best, since we have many raw materials here and we know how to process them cheaply.

The problem, says Haskin, is energy. The cost of lifting objects away from Earth's gravitational pull is, like its goal, out of this world. So, rather than hope for an energy renaissance when new technologies would revolutionize our ability to use energy, humankind might better use what raw materials space has to offer. "Moon rock is the logical first choice of material to use for building things in space," concludes Haskin, "because the Moon is very close to Earth in terms of space travel, and moon rocks are made of useful materials."

The main effort in Haskin's laboratory is study of compositions of rocks from Earth and Moon to determine how chemical separations

occurred in the hidden interiors of those planets. This work requires laboratory experiments on how chemical elements behave in molten rock at 2,700°F, experiments patterned after those commonly done in water at ordinary temperatures. One technique the researchers adapted for this study was electrochemistry.

As a result of their interest in future activities in space, Haskin and Lindstrom were aware of how useful building materials from the Moon would be. As geochemists, they also recognized how difficult it would be to adapt methods used for smelting ores on Earth for use on the Moon. Thus, when their electrochemical measurements in molten rock were successful, they speculated that an extension of the technique, electrolysis, might be a feasible method for refining lunar materials.

Electrolysis is a method used on Earth to separate or purify certain metals by sending an electric current, set up by opposing electrodes, through molten rock. Aluminum, for instance, is electrolytically extracted. And high-quality copper comes from an electrolytic process that purifies low-grade forms of the metal.

In principle, the Moon-mining operation envisioned by Haskin and Lindstrom is very simple. It requires silicate rock (of the kind found commonly on the Moon), a container to melt it in, material for electrodes, and sunlight for heat and electricity.

The two scientists have demonstrated the basic methods of their Moon-mining model on a small scale in the laboratory. First, they mix up a batch of chemicals to simulate compositions of lunar rocks like those collected by the astronauts. They heat the concoction in a furnace (on the Moon, this step would be solar-powered) until it becomes a molten silicate. Into the liquid they insert positive and negative electrodes. The

Mining the Moon

In final step of the study, Lindstrom uses an electron microprobe to determine the exact composition of material deposited on the negative electrode and to examine the changes of chemical composition of the residual molten rock.

resulting voltage provides the energy for the chemical separation of metal from the liquid. The process readily separates iron at one electrode, and at the opposite electrode oxygen is released.

Two other probable products of such electrolysis would be silicon and titanium, which have been separated partially in the laboratory, but which dissolve in the metal of the electrode. Haskin and Lindstrom note that such bugs often trouble new fields of experimental science and are compensating by trying alternative electrode materials.

If silicon can be obtained, the technique would mean a growth industry for using molten rock on the Moon.

"With silicon," says Haskin, "we could manufacture more solar cells, to create more electricity, to make more iron, to make more silicon—and so forth."

One catch to these kinds of materials-scavenging operations on the Moon, points out Lindstrom, is that engineers might have to change their point of reference. Instead of making products out of the best material, they will have to make the best products they can out of the materials at hand.

"For example," says Lindstrom, "there is no particular reason why we can't make electrical conductors out of iron. On Earth we use copper because it's a better conductor and because it's relatively cheap. Well, it's not cheap on the Moon, and we might not be able to get it at all."

What are some of the other products possible from electrolytic raw materials?

A few of iron's uses are as electromagnet cores, structural steel and wire (when alloyed with other metals), and plating for solar collectors. Silicon converts into computer chips, transistors, and solar cells. Titanium can be alloyed with iron to make steel, used for general construction material and formed into



a lightweight metal used for space vehicles.

Oxygen is the main gas that is released in the process. One obvious use would be in life-support systems. Another is as an oxidizer for rocket fuels. In addition, small quantities of several other gases are given off by heating lunar soil. These contain hydrogen, carbon, and nitrogen—elements also vital to life support.

Speculating about the possibilities of such Moon-mining operations, one officer for the L5 Society—an organization devoted to space colonization—estimated that these processes could produce more than 90 percent of the material required for building and living in space stations.

Mining the Moon could boost humankind toward realizing the seemingly way-out predictions of Princeton University physicist and futurist Gerard O'Neill. He envisions a hollow, spinning space settlement in the shape of a bicycle wheel miles wide. Inside, up to 10,000 settlers would live with their feet walking the surface away from the axis, in the style of mice

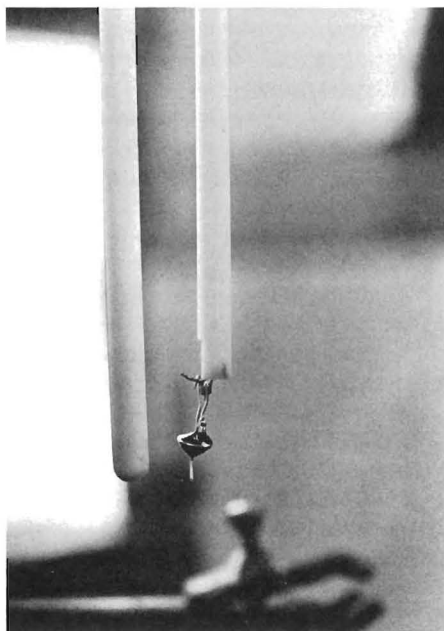
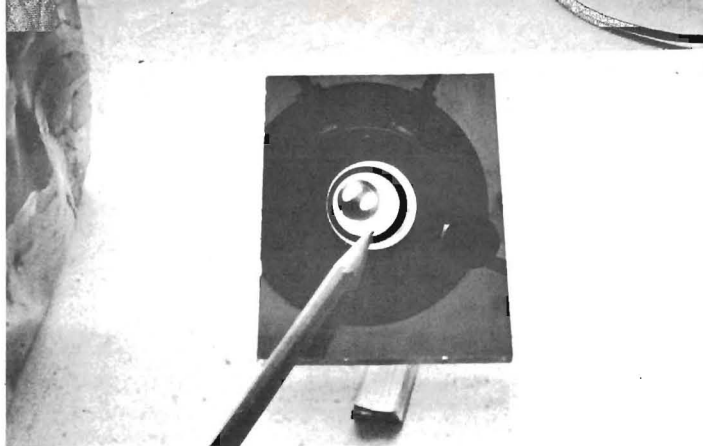
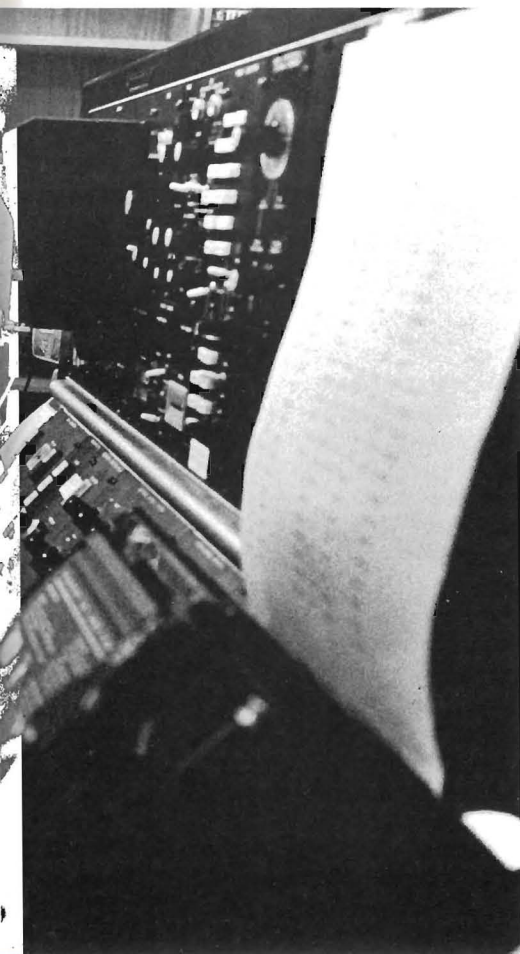
running on a giant revolving drum. Mirrors would guide the constant sunlight past cosmic ray shields, and train it on the living area.

Among the features in this theoretical model are "supermarket farming" on large shelves, attractive landscaping, and weather patterned after that of Earth.

Is all this high living centuries away? Not necessarily. O'Neill and others predict structures of this kind, as well as armadas of glass-winged solar power stations that will orbit Earth like giant butterflies, within the next fifty to seventy-five years.

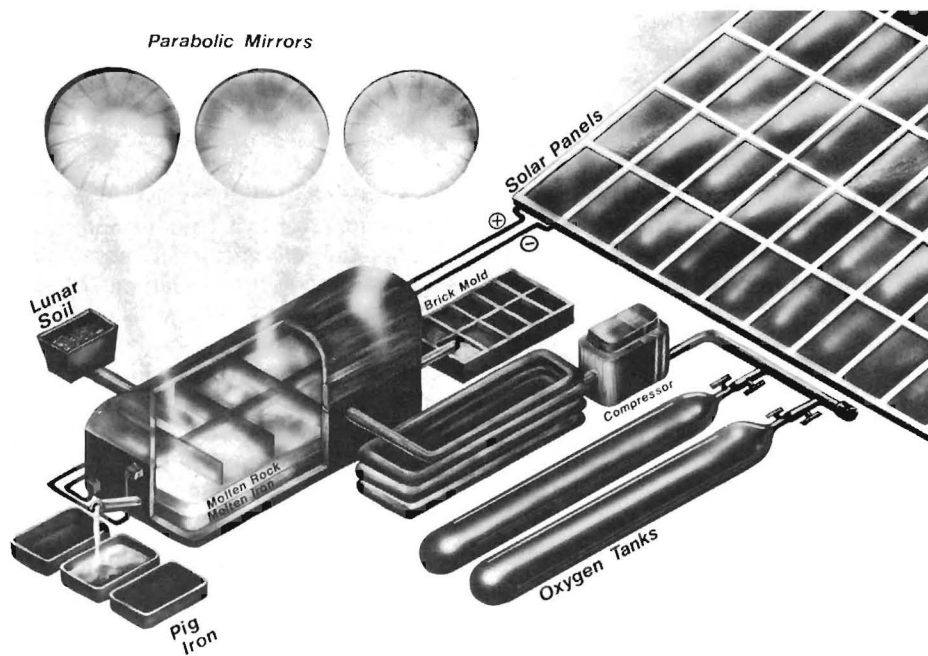
But to get there from here requires a first step. As physicist and mathematician Freeman Dyson once theorized: "In the long run, the only limits to the technological growth of a society are internal."

Haskin and Lindstrom—and scientists like them—have begun chipping away at some of those limits. "Basically, we're trying to add some real laboratory experimentation," says Haskin, "to some of the theoretical ideas people are discussing."



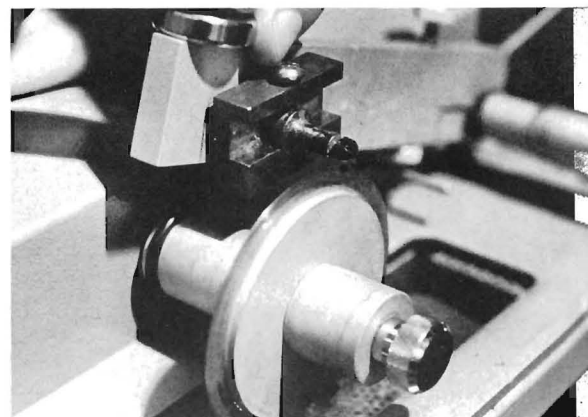
In a laboratory model, Haskin and Lindstrom heat simulated lunar rock to a molten state, then separate elements by electrolysis. In a view up into the furnace, the two glowing objects are the tube holding the temperature measuring thermocouple and the molten rock itself.

To go into the furnace, the mock lunar sample is suspended in a loop of wire which serves as a positive electrode. The negative electrode passes through the center of the sample.



LUNAR SMELTER

A schematic illustration shows products, processes, and energy sources. Using sunlight for heat and electricity, lunar soil yields iron, oxygen, and a material for making glass products.



The tiny simulated rock, cooled after heating and electrolysis, is sawed in two along the center wire to see what has been deposited.

Deadly Messages

By Jill Murray Draper

Curt Thies, professor of chemical engineering, has spent nearly twenty years studying a novel packaging technique called microencapsulation. The potential for this technology is immense, from its humble pioneer product, carbonless copy paper, to a new way of treating cancer.

Have you ever seen those message-delivery systems in department stores and office buildings in which notes are popped into plastic capsules and circulated throughout a network of tubular arteries?

An international team of scientists working at Washington University is now testing a similar idea to send encapsulated letter bombs to tumors in the body. By injecting tiny, biodegradable "microspheres," armed with anticancer chemicals, into veins and arteries, the scientists are making use of the body's own delivery system to mail deadly messages to tumors.

Called targeted drug delivery, the process promises to make chemotherapy more accurate and less dangerous by concentrating drugs where they can do the most good—where tumors are.

"In traditional chemotherapy," observes biomedical engineer Curt Thies, Ph.D., professor of chemical engineering in the School of Engineering and Applied Science, "you often bring the patient to the brink of death in order to kill the cancer. By localizing the drug concentration, we hope to achieve more effective treatments without bad side effects." Thies is a member of the team perfecting the tiny drug-filled missiles.

Cancer researchers have long dreamed of finding a "magic bullet"—a drug that, once inserted, would travel straight to the cancer cells and destroy them while leaving normal cells untouched. The drug would be "smart" because it could pick and choose which cells to attack.

"The magic bullet approach is a

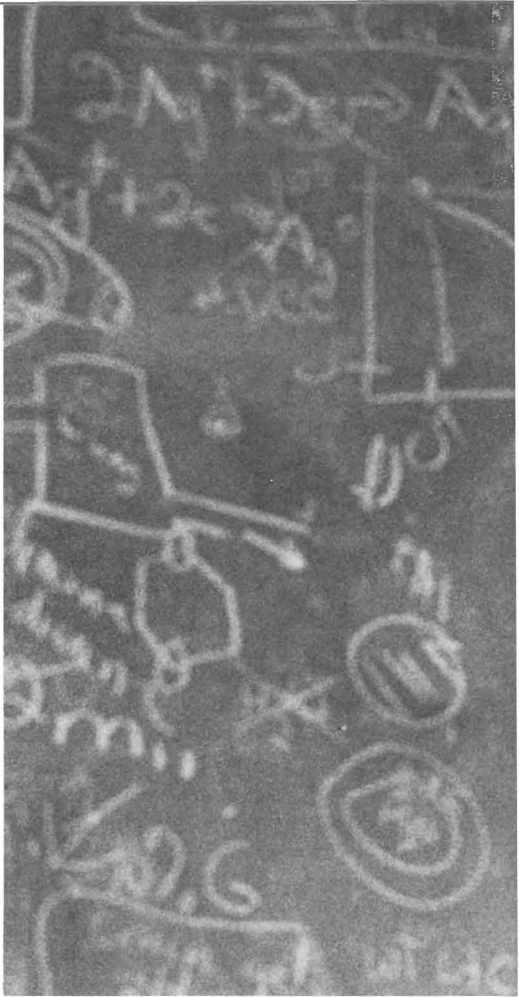
nice dream," says Thies. "At this stage, though, it has yet to be realized. There's no drug now that kills only cancer."

He and his colleagues believe the workable approach is to hit the cancer where it is by enclosing anticancer drugs in capsules and physically delivering them to the diseased area.

This ground-zero strategy can be carried out in several ways. One approach, intra-arterial infusion chemotherapy, involves using a catheter to place drug-loaded microspheres in the major arteries leading to a cancerous organ. The result is twofold. Designed to reduce blood flow, the microspheres starve the tumor as they simultaneously discharge cancer-killing agents at the site. After a period of time, the capsules dissolve and blood flow returns to normal.

A second method, called size targeting, makes use of the body's natural filtering system. When injected intravenously, drug-filled microspheres of a certain diameter catch in the lungs, while slightly smaller particles travel to the liver and spleen or to the lymph system. Once the capsules have lodged at the desired site, the drugs inside slowly leach out, thereby delivering a high concentration of the agent to the cancer.

Though simple in concept, targeted drug delivery is a tough design problem which has triggered the international collaborative effort. Working with Thies are Fred Valeriote, Ph.D., former professor of radiology at the School of Medicine who is now with the Michigan Cancer Foundation in Detroit; Dien-ming Chen, Ph.D.,

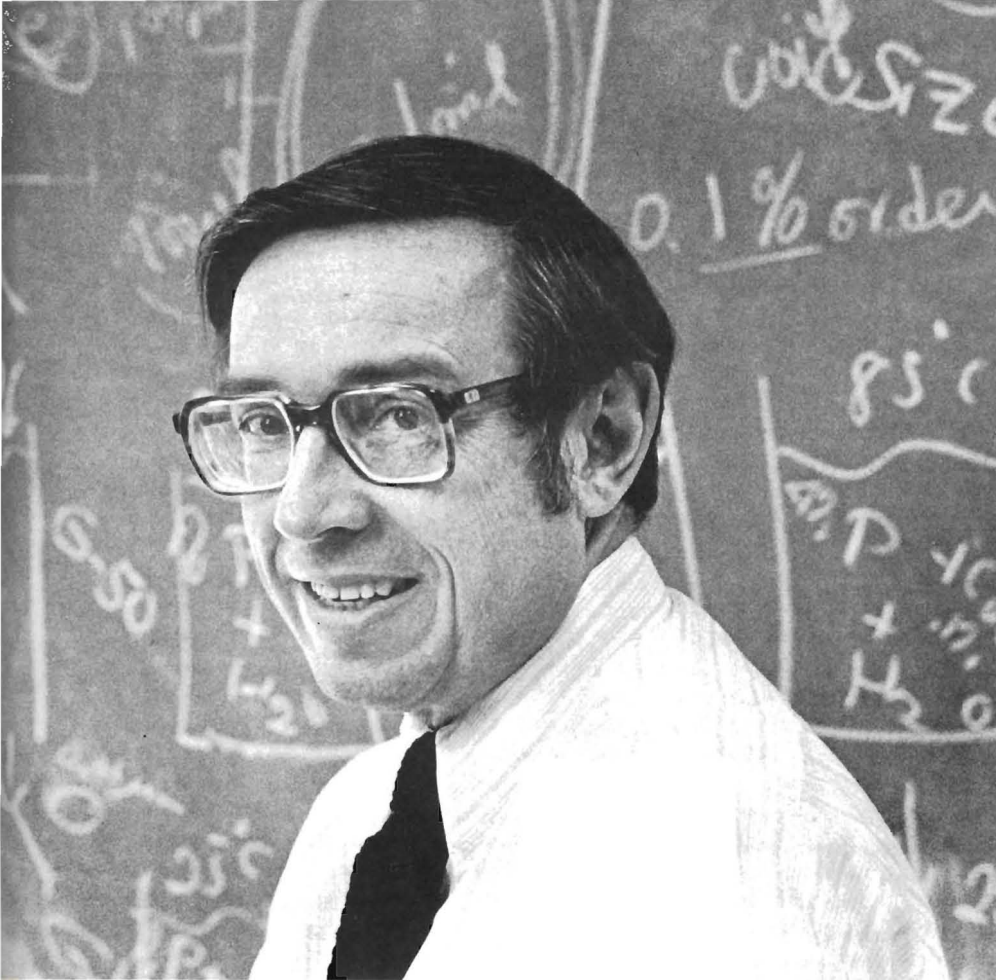


assistant professor of cancer biology in radiology; and a team from the University of Paris School of Pharmacy which includes Francis Puisieux, Ph.D., and three Ph.D.-candidate exchange students, Jean-Pierre Benoit, Marie-Christine Bissery, and Michel Cavalier.

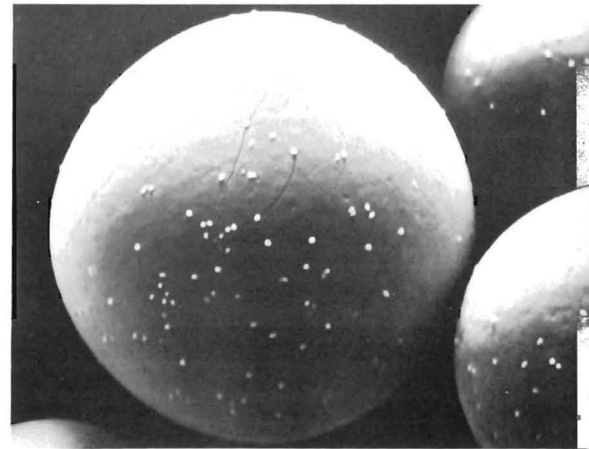
"Basically, we're dealing with a packaging problem," says Thies to explain the large number of researchers from varying disciplines. To make targeted drug delivery successful, the drug-loaded particles—about the size of sugar grains—must meet very exacting size and drug-release requirements. In addition, the particles must be made from materials that biodegrade at known rates.

Thies and the French team spent the last year developing a microsphere-manufacturing process, during which drugs are dissolved or suspended in a solvent that contains a biodegradable plastic. Droplets of the resulting mixture are formed and solidified to yield the microspheres.

This intricate technique is further complicated by medical controversy. Physicians disagree about which cancer drugs work best, which time release is most effective, and how long the microspheres should take to



Thies joined the faculty in 1973 after eight years of industrial research.

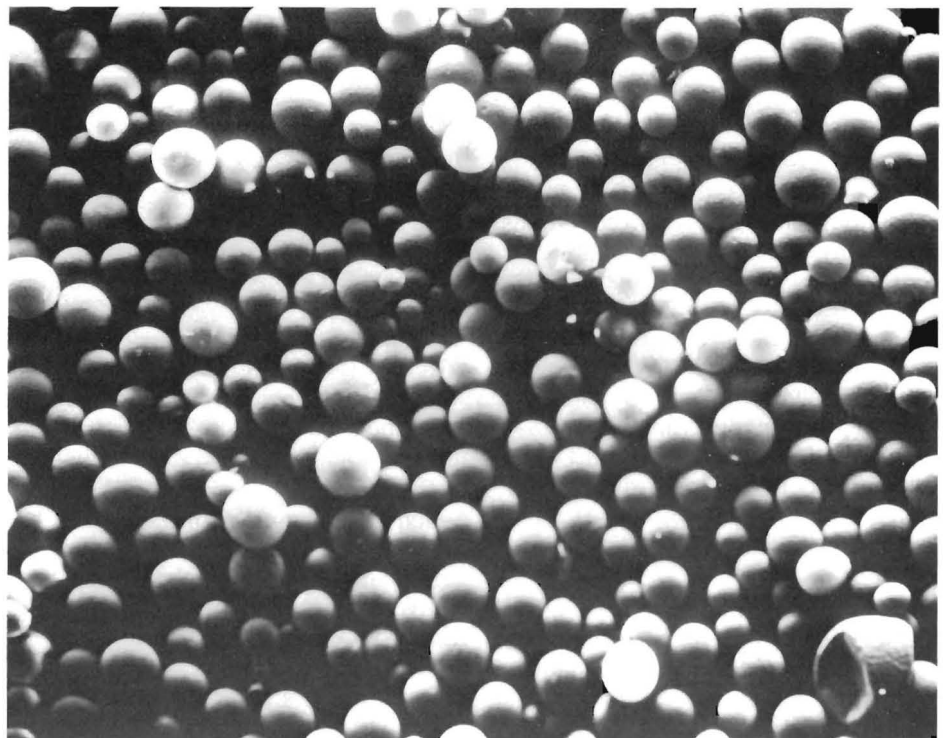


Magnified 500 times for the photo, these anticancer microspheres for intra-arterial use are actually about the size of sugar grains. They are now manufactured in the laboratory for research purposes.

dissolve. "There are a number of chemotherapy agents now in use and a range of coating materials available," Thies notes. "Each drug-plastic combination requires a customized manufacturing process."

The collaborative team has tested several types of drug-loaded microspheres in a laboratory setting. "We'll rely on animal experiments to tell us where to go next," he says. During the coming year evaluations of how the particles perform in animals will be carried out by Bissery at the Michigan Cancer Foundation under the direction of Valeriote. Meanwhile, at Washington University, Chen is experimenting to establish how rapidly various types of microspheres are attacked by the body's immune system.

"Even though the microspheres are primitive compared to something that could single out cancer cells (a magic bullet), I believe we're taking a realistic approach," says Thies. "We're like the Wright brothers learning to fly. You've got to take that first step before inventing the jet plane—much less something as sophisticated as a magic bullet that operates like a 'smart' bomb and can zero in on its target."



The drug-loaded particles, shown here at a magnification of fifty, must meet exacting size and drug-release requirements. In addition, the plastic coatings must biodegrade at a specific rate when injected inside the body.

Comment

Washington University's Baroque Festival is past, but its memory lingers like the afterimage of a vast panorama, the recollection of a beautiful melody. The undertaking was ambitious—so ambitious that in the throes of preparation even those most committed wondered if the whole idea had not gotten completely out of hand—but it was done and done with taste and creativity. It charmed almost everyone involved.

Andrew Porter, music critic for the *New Yorker* magazine, threw bouquets in a manner that belied the droll reserve of that publication. On the scene, he attended every session of the symposium, he listened, he contributed; he responded with appreciation through two of the three performances of *Orlando*. He wrote in the March 14 magazine that although Handel had not yet taken his due high place in operatic repertory in this country:

"Among small-theatre presentations there were two so remarkable as to be, I'd say, international landmarks in the Handel revival. One was the American Repertory Theatre's *Orlando*, conducted by Craig Smith and directed by Peter Sellars...; and the other, Washington University in St. Louis's *Orlando*, directed musically and dramatically by Nicholas McGegan, which was performed thrice last month as part of the University's Baroque Festival."

Porter praised McGegan, noting that he first admired McGegan's work twelve years ago when McGegan was an undergraduate at Cambridge University, and explaining, "The *Orlando* he directed for Washington University was the most thoroughgoing essay in Handelian operatic reconstruction I have encountered; it brought together all the research and experiment that have been conducted in the fields of musical execution, stage setting, lighting, acting style, and orchestra-to-stage

relationship."

Of the sets by Scott Blake and staging in Edison, he wrote, "But as a zestful, enthusiastic vision of a Baroque stage in motion this was a brilliant achievement." Of the small ensemble playing period instruments, he said, "The beauty, the gentleness, the vigor and variety of Handel's scoring were revealed as by a modern orchestra they cannot be." He praised the singers and the "enchanted" whole.

Porter is a fan of Handel's; his enthusiasm for the music was ensured, but, as such, his critical vision was sharp. Washington University's Baroque Festival won his heart and mind. Other reviewers of the opera writing before Porter quite agreed, and the house at Edison was packed for all three performances.

The symposium on that elongated weekend was attended by 154 scholars from Maryland to New Mexico. Their response gave back doublefold the care taken to insure its academic soundness. One participant wrote later of "the solid symposium that generated new friendships and new ideas." The following-opening-night reception given by the Seven-Up Company at its Clayton world headquarters was flushed with the aura of success. Participants glowed; their audience was ebullient.

Less spectacular than *Orlando*, but as much a teaching part of the festival, was the exhibition "Baroque Theatre and Stage Design," which hung in the University's Gallery of Art in Steinberg Hall from February 24 through April 10. To the color-saturated eye of the twentieth-century viewer, its sepia and faint color-wash material is decidedly low-key, but the mounters of the exhibition took that as an advantage and gave us an exhibit of warmth and elegant simplicity. It was a walk-through learning experience to be undertaken in an atmosphere of subdued light (to protect the paper of the sixteenth-, seventeenth-, and eighteenth-century

etchings and engravings) and quietude.

The gallery walls were subtly painted in six different colors and shades to define spaces and provide cool and warm settings. A chair-rail was installed on the walls at ten feet to visually lower the gallery's ceilings so the smallness of exhibit material was not overwhelmed. Special pedestals and cases were built to display the books. And the gallery's natural light was blocked out by stage drops painted and hung to bring the viewer into the settings displayed with dramatic effect.

The creativity and attention to detail of more than two months of planning and a month of installation by the gallery's staff under director Gerald Bolas shown out.

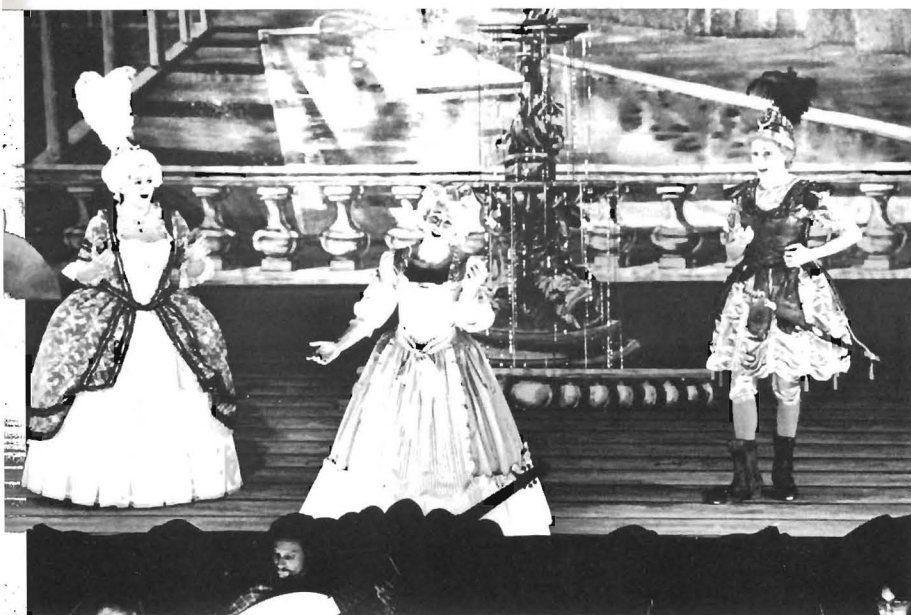
This fastidious mindfulness went into all of the Baroque Festival. It was a coup, a smash, a sensation.

What can be captured of that in word and picture will be contained in a volume—underwritten by the Seven-Up Company—now being formulated. It will both salute and attempt to preserve some of the presentations of the symposium, the drama of the opera, the visual education of the exhibit.

Tres bien!

D.L.W.

A la Handel



At top, director Nicholas McGegan. Middle right, Zoroastro and his three genies before the Mouth of Hell; middle left, Orlando. Above, Zoroastro: left, from left, Angelica, Dorinda, and Medoro.

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